ASSESSMENT OF PROPANE SUPPLY AND DISTRIBUTION IN ONTARIO

Report prepared for the
ONTARIO MINISTRY OF ENERGY

Ontario Ministry of Energy

Honourable
Robert Welch, Q.C.
Minister

Energy Ontario

ISBN 0-7743-8046-2
Printed January, 1983
$2.00

This report, prepared for the Ministry of Energy for Ontario, is published as a public service for the information of the public. The Ministry does not, however, warrant the accuracy of its contents and cannot guarantee or assume any liability for the effectiveness or economic benefits of the devices and processes described in the report.

ASSESSMENT OF PROPANE SUPPLY AND DISTRIBUTION IN ONTARIO

Report prepared for the
ONTARIO MINISTRY OF ENERGY
by
Middleton Associates
L.P./Gas Services
Mueller Associates, Inc.
Toronto, Ontario
March, 1982

ABSTRACT

Ontario's traditional propane market is undergoing rapid change. This is due both to federal and Ontario government programs to encourage the replacement of oil with other fuels and to an increase in world production of propane. The following report examines these trends and their implications for the Province of Ontario.

TABLE OF CONTENTS

		Page
1.	INTRODUCTION AND SUMMARY	1
1.1	Background	1
1.2	Scope	2
1.3	Summary	2
2.	PROPANE PRICES	6
2.1	Overview	6
2.2	Export Prices	6
2.3	Domestic Wholesale Price	9
2.4	Retail Prices	11
2.5	Projected Domestic Wholesale Price of Propane	18
3.	PROPANE MARKETS	21
3.1	Disposition of Propane	21
3.2	Producer Consumption and Feedstock Use	21
3.3	Overview of Propane Sales	23
3.4	Propane Energy Uses	23
3.5	Forecast Propane Demand	26
3.6	Markets for Ontario Propane in the United States	30
4.	PROPANE SUPPLY	36
4.1	World LPG Trade	36
4.2	Canadian Propane Supplies	42
4.3	Ontario Propane Supply	47
5.	TRANSPORTATION AND DISTRIBUTION OF PROPANE	53
5.1	Propane Transportation	53
5.2	Propane Distribution	57
6.	PROPANE SAFETY	60
6.1	Introduction	60
6.2	Safety Regulations	60
6.3	Safety Risks in Bulk Transportation and Storage	62
6.4	Local Distribution	64
6.5	Vehicular Use of Propane/Butane	67

1. INTRODUCTION AND SUMMARY

1.1 BACKGROUND

Although in abundant supply, propane has not attracted significant interest in traditional heating markets. Most of Canada's propane is exported to the United States. To encourage the demand for propane, the federal government, as part of the Federal Canada Oil Substitution Program, provides for conversion grants from oil to propane and other fuels. Within Ontario, the Ministries of Energy and Transportation and Communications have succeeded in promoting propane use in the transportation sector. Many observers believe that with aggressive programs, the transportation market may in fact be a market capable of utilizing a significant fraction of current propane exports.

Utilization in transportation markets is only one of several events which may alter what until now has been a relatively stable supply/demand relationship. Recent events in the Middle East and Latin America are changing the supply picture. For example, a number of OPEC companies are building facilities to recover LPGs from oil and gas production. Previously, these products were either flared or pumped back into the ground. This sudden increase in production may flood the world propane market and reduce the American demand for Canadian propane.

To remain well informed on the changing propane environment, the Ontario Ministry of Energy commissioned Middleton Associates, LP Gas Services and Mueller Associates to examine seven areas:

- the traditional propane market
- new market developments for propane
- traditional propane supply
- new propane supplies
- traditional propane distribution in Ontario
- new trends in propane distribution in Ontario
- the pricing effects created by these new supplies and trends

1.2 SCOPE

Information was acquired from interviews with industry experts, a literature review, Statistics Canada and the National Energy Board. In some cases, data provided by these sources were incompatible. Resolving discrepancies among the data sources was outside the scope of this study. In addition, because the propane environment is so dynamic, this study can only be considered as a snapshot of the situation to March 1982.

Forecasts of propane supply and demand are closely related to performance of the economy as a whole. Forecasting economic activity was outside the scope of the project, and therefore no evaluation of the implicit or explicit economic assumptions behind forecasts was made. Further, since the terms of reference did not emphasize it, demand analysis has been based on simple, though reasonable, assumptions.

1.3 SUMMARY

1.3.1 The Traditional Propane Market

There are three traditional markets for propane available in Ontario: the petrochemical industry in Sarnia, exports to the United States, and domestic sales. In 1980, of the 2.2 GL of propane available in the province, about 60 percent was exported, 20 percent went to domestic markets for use as a fuel, and 15 percent was used as a petrochemical feedstock. The other five percent is accounted for by inventory change, shipments to other provinces, use by the energy supply industries and losses.

Propane is used as a fuel in all sectors of the economy: residential, commercial, industrial, agricultural and transportation. There are three main attributes of propane that have stimulated its use:

- clean-burning - because propane is clean-burning, it can be used indoors without fear of asphyxiation or product contamination. This has encouraged its use in agriculture and in industry to operate fork-lift trucks.

- portable - propane can be stored in portable cylinders or in mobile fuel tanks. This has encouraged its use on construction sites, in recreational vehicles, and in other applications where other fuels are less convenient.

- economy - propane is cheaper than oil as a result of government policy and traditionally was cheaper than electricity. This made propane a very attractive fuel for residential and commercial heating where natural gas was unavailable.

1.3.2 New Markets for Propane

In recent years, use of propane in the transportation sector has grown dramatically. This growth has been stimulated by government incentives in the form of the waiving of road tax on propane sold for transportation and the exemption of propane vehicles from retail sales tax. Growth in propane use in the transportation sector is expected to continue. Use in 1980 in Ontario was about 2.0 ML. Projected use in 1985, 1990 and 1995 is 201.3, 1000.1 and 2815.2 ML/yr respectively.

In the residential sector, modest growth is expected to 1985 as a result of the Canadian Oil Substitution Programme. After 1985, use is expected to decline as gas distribution systems expand and energy conservation measures are more fully adopted.

In all other sectors, use is stable or declines slightly over the next 15 years.

1.3.3 Traditional Propane Supplies

There are two dominant sources of propane supply in the province: production by refineries and shipments of propane from gas processing plants in Alberta. Very small amounts of refinery produced propane are brought into the province from Quebec. In 1980, shipments from Alberta accounted for 76 percent of the total available propane in Ontario.

The future supply of propane is a function of the production levels of petroleum and natural gas. Refinery production is expected to be fairly stable and gas plant production is expected to increase to the mid 1980's and then decline.

1.3.4 New Propane Supplies

There are three potential new sources of supply for Ontario: propane that was exported to the United States, propane produced by synthetic crude oil plants and propane from frontier areas.

The construction of large gas liquids facilities in the Middle East and the well-developed import terminals and storage facilities in the United States, coupled with the global propane surplus, is expected to decrease the American requirement for Canadian propane. This propane can readily be diverted to an expanding Ontario market.

Propane can be produced by synthetic crude oil plants or from frontier areas (especially the Mackenzie Delta and the Scotian Shelf). These sources may provide significant volumes of propane by 1995.

Butane can be readily substituted for propane in the transportation sector, especially during warm weather. At present, large quantities of butane are exported to the United States. This could be used in the Ontario transportation system.

The supplies of propane in 1985 are adequate to meet the projected demand. If butane is used for transportation during summer months, no supply shortage is anticipated by 1995.

1.3.5 The Traditional Distribution System

Except for the northeastern part of Ontario, most of the propane arrives at Sarnia via the Interprovincial Pipeline as natural gas liquids. Propane is derived from the liquids at the Dome fractionation plant.

Propane is delivered to bulk distribution facilities from the Dome plant and from oil refineries by rail and tank trucks.

Propane is distributed from bulk distribution facilities of which there are 73 in Ontario. Three types of distribution exist:

- "bobtail" deliveries - tank trucks deliver propane to customers who have storage tanks, much like fuel oil is distributed.
- cylinder deliveries - customers who use cylinders for fork-lift trucks and other applications have these delivered to them by the distributor. The distributor fills the cylinders at the bulk storage plants.
- the small cylinder user - customers using 30 L cylinders, such as for barbecues or propane torches take these to a filling centre where they are filled from a large storage tank.

1.3.6 New Trends in Propane Distribution

Additional quantities of propane can be delivered to Ontario via Interprovincial Pipeline's number 2 line and via the Cochin Pipeline after 1985. As the volume of propane shipments rises it will become economic to install receiving facilities so that it can be shipped within the province via existing petroleum product pipelines.

Although the extent of the propane distribution system is expected to increase, no change is anticipated in the nature of the system. Since most transportation users will belong to fleets, an extensive system of retail outlets is not anticipated. The distributor will simply fill a storage tank at the fleet garage or storage area from which vehicles will be refuelled.

The distribution to public service stations will be similar to that for fleet refuelling.

1.3.7 Propane Pricing

Wholesale prices in Ontario are set such that they are below the NEB minimum export price (which is usually related to the world propane price) and the domestic crude price. In the future, when propane will compete less with No.2 fuel oil and more with gasoline, the wholesale price may rise above the domestic crude oil price, although the two will still be related.

The Alberta-Ottawa energy pricing agreements set a maximum price on oil through 1986 if world oil prices remain high. Since world oil prices are falling, and are expected to continue to fall (in constant dollars) for the next few years, the Canadian oil price, and the Canadian wholesale propane price are expected to track world oil prices.

Retail propane prices are set according to wholesale prices, transportation costs and distribution costs. Naturally, the retail price varies depending on the location of the customer, the quantity of propane purchased at a time, and whether propane is taken from a bobtail or in cylinders.

2. PROPANE PRICES

2.1 OVERVIEW

The price of propane is not regulated in Canada. It is the only major form of energy whose price is not determined by regulation or government agreement.

The National Energy Board sets a minimum export price for propane. The minimum export price is determined so as to make Alberta propane competitive with Gulf Coast propane at St. Paul, Minnesota.

The wholesale price for domestic propane in Alberta is determined by the minimum export price and the domestic price for crude oil. The wholesale price for domestic propane is roughly equal to the lower of these two prices. Propane competes with home heating (No. 2) oil in most of its current applications, so the wholesale price of propane cannot be appreciably above the price of home heating oil (as approximated by the domestic price of crude oil) without substantial loss of sales. At the same time propane has the option of selling into the domestic or export markets. Hence, the domestic price generally does not differ substantially from the export price.

The wholesale price for propane in Ontario is generally equal to the wholesale price for domestic propane in Alberta plus the cost of transportation to Ontario. Within Ontario the price to propane dealers reflects this pattern plus the cost of rail or truck transport from one of the Ontario or Montreal oil refineries, or the Dome fractionation plant in Sarnia.

2.2 EXPORT PRICES

The National Energy Board sets a minimum export price for Canadian propane. The minimum export price is related to the posted price for propane at Mt. Belvieu, Texas, the principal propane market in the United States. The history of propane and No. 2 oil prices at Mt. Belvieu over the past five years is shown in Figure 2.1.

The minimum export price is calculated from the Mt. Belvieu price by adding the transportation cost from Texas to St. Paul and subtracting the transportation cost from Edmonton to St. Paul. This has the effect of making Canadian propane exports competitive with U.S. supplies in St. Paul, one of the major American markets.

The minimum export price calculated in the manner described above is reviewed, and possibly adjusted, in light of other factors such as inventory levels and the domestic price in Canada. The Mt. Belvieu posted price and minimum export price over the past five years are shown in Figure 2.2.

FIGURE 2.1

MT. BELVIEU PRICES FOR PROPANE AND NO. 2 OIL

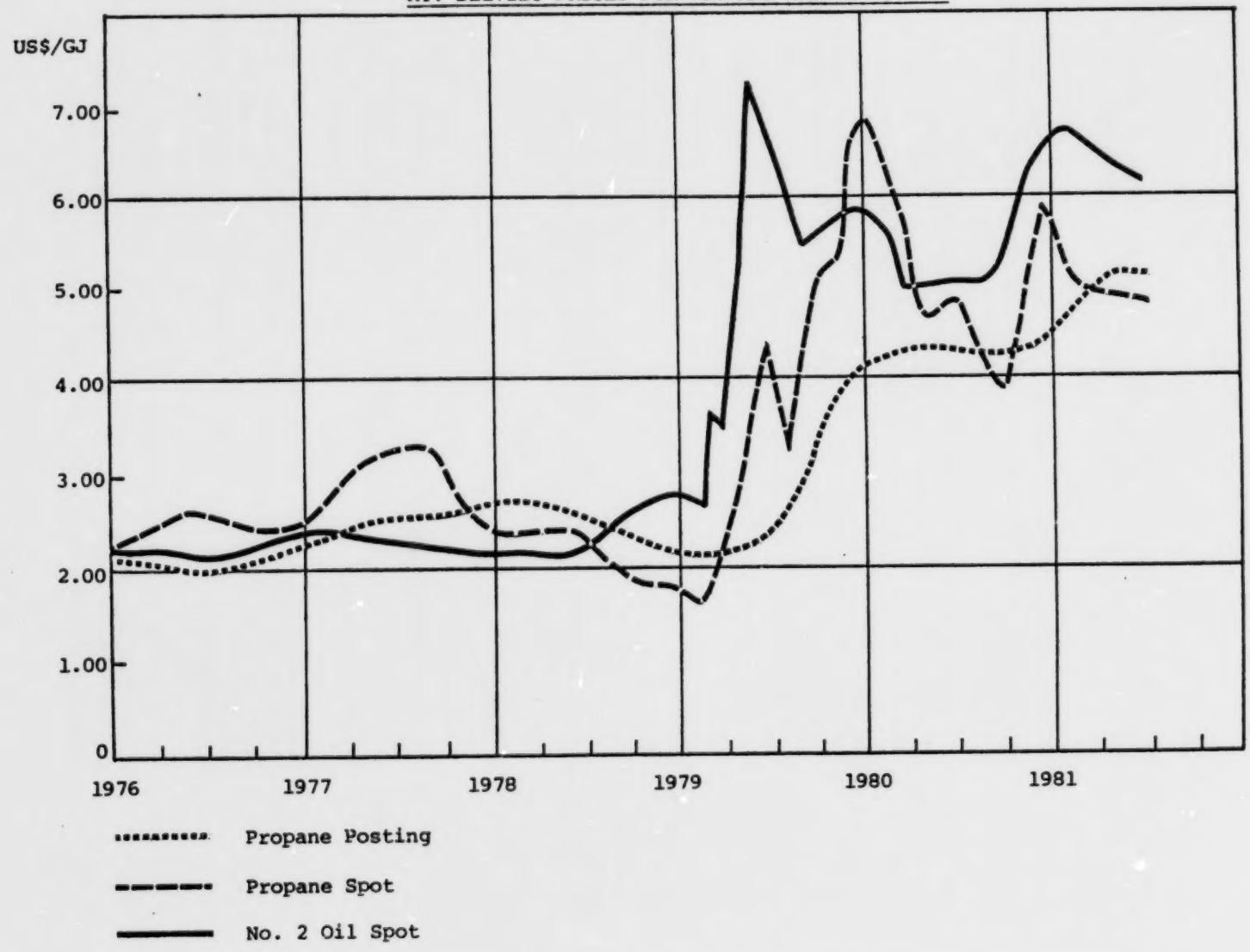
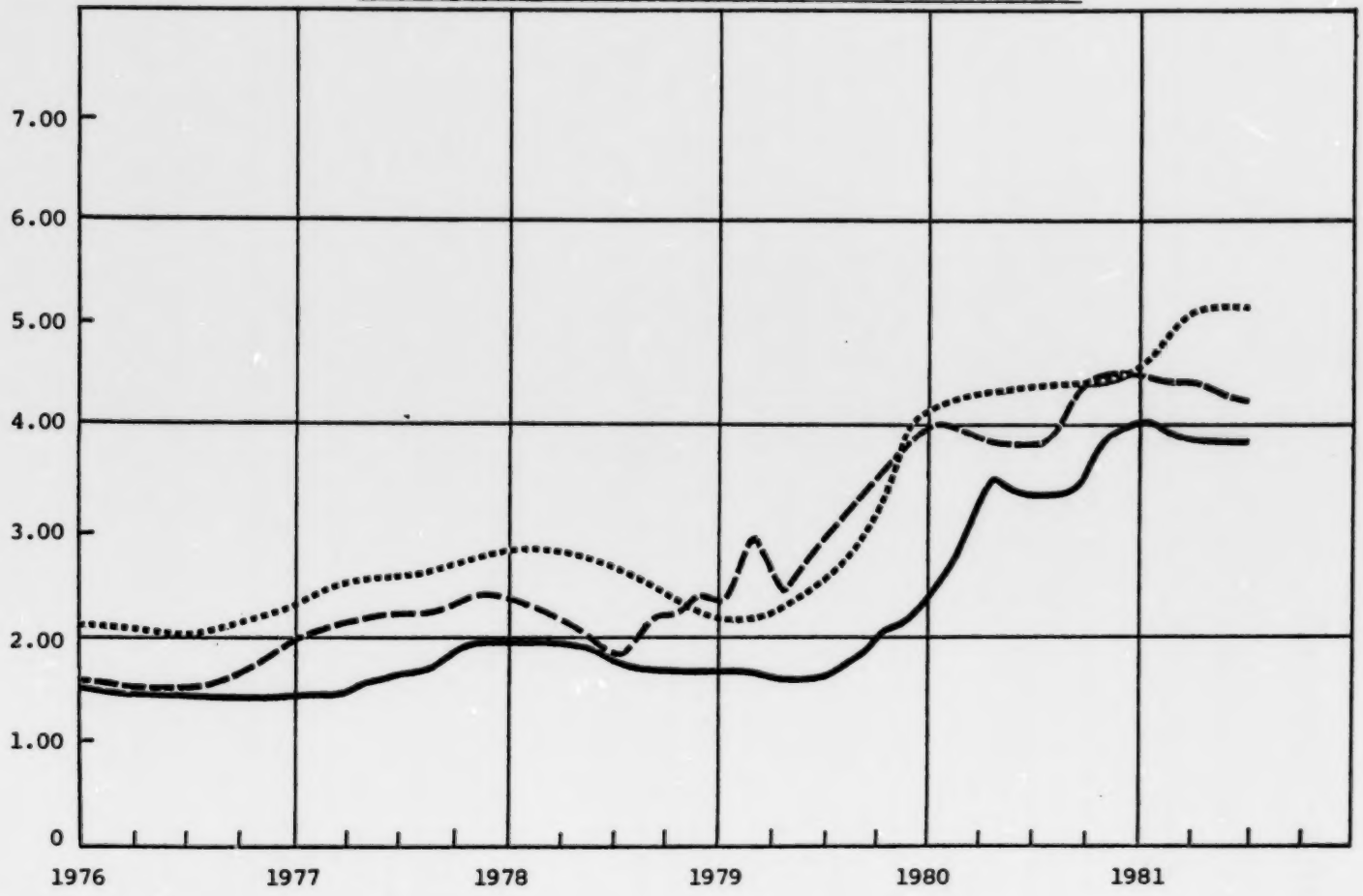


FIGURE 2.2

RELATIONSHIP BETWEEN U.S. AND CANADIAN EXPORT PRICES



The minimum export price is reviewed monthly by the NEB, but adjustments are only made if they are deemed necessary. Three adjustments were made in 1979 and five were made during 1980.

2.3 DOMESTIC WHOLESALE PRICE

2.3.1 Wholesale Price F.O.B. Edmonton

The wholesale price for propane in Alberta is closely related to the export price for propane and the domestic price of crude oil.

In most existing applications, propane competes with No. 2 oil. The price of No. 2 oil is closely related to the price of crude oil. The domestic price of propane cannot appreciably exceed the price of No. 2 oil without endangering these markets. Thus, the domestic crude oil price sets a ceiling for the domestic wholesale price of propane.

The NEB will not authorize propane exports at less than its minimum export price. Under the National Energy Board Act of 1959 and subsequent amendments, the Board must be satisfied that the prices charged for exports are just and reasonable in relation to the public interest. In recent years, this has usually been interpreted to mean that export prices must be higher than domestic prices.

The domestic and export prices of propane and the domestic prices of crude oil and natural gas over the past five years are shown in Figure 2.3. The figure illustrates that over most of this period, the domestic price of propane has been constrained by the export price of propane.

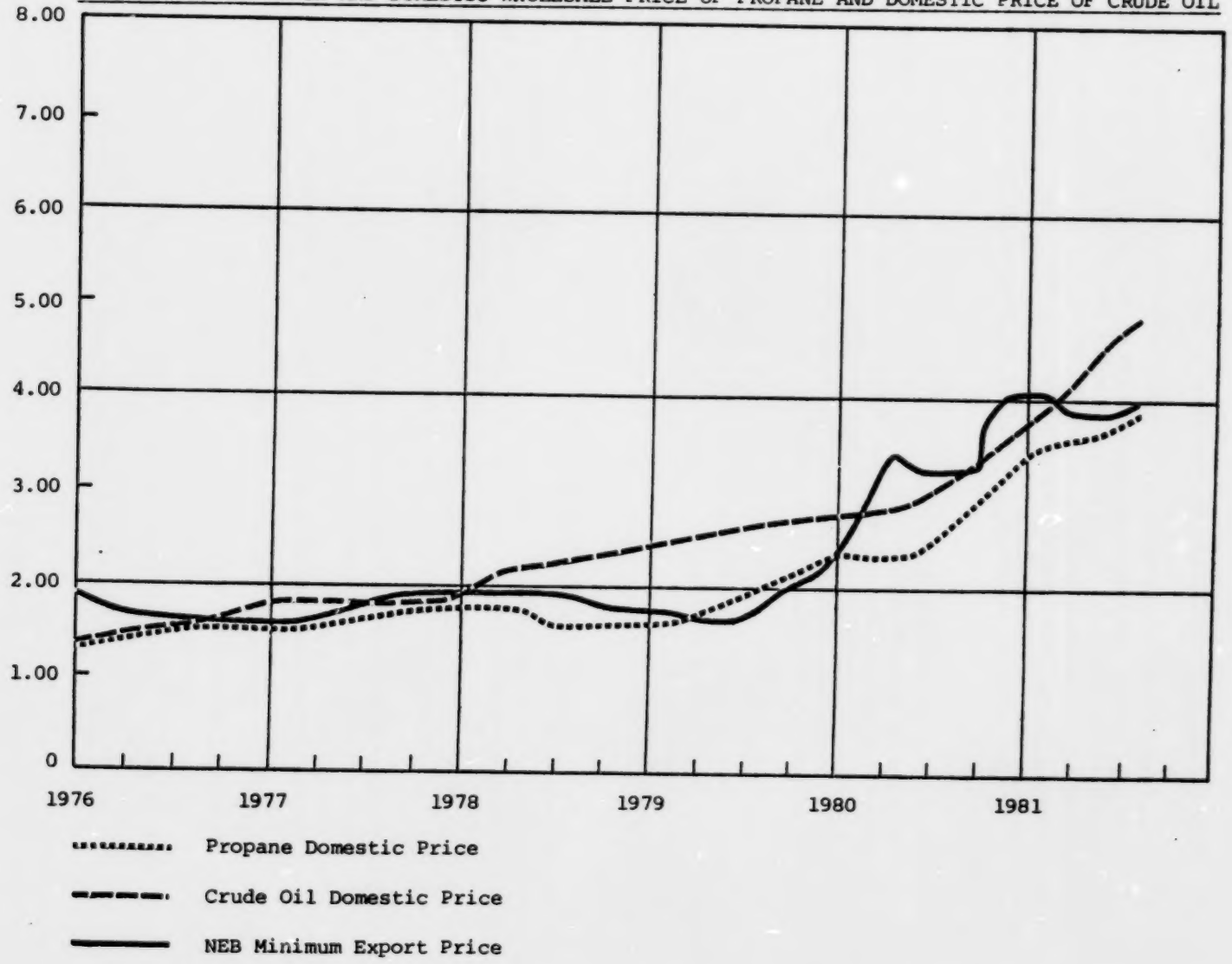
2.3.2 Wholesale Price in Ontario

The wholesale price of propane in Ontario is generally equal to the domestic wholesale price F.O.B. Edmonton plus rail transport from Edmonton to the selected location. Very little of the propane used in Ontario is actually brought in by rail except in the northwestern part of the province. Almost all of the propane used in the province is produced by refineries in Montreal or Ontario or the Dome fractionation plant in Sarnia. It appears that all of these sources use the Edmonton wholesale price plus rail transport as the basis for setting their prices.

The price of propane to dealers in centres that do not have a refinery is usually equal to the price at the nearest refinery or fractionation plant plus the cost of rail or truck transport.

FIGURE 2.3

MINIMUM EXPORT PRICE AND DOMESTIC WHOLESALE PRICE OF PROPANE AND DOMESTIC PRICE OF CRUDE OIL



2.4 RETAIL PRICES

2.4.1 Propane Prices in the Residential Sector

Consistent data on the price of propane to residential customers are not published. Estimates of the average annual price of propane for residential customers for the past several years are derived by dividing distributor revenue by the volume sold to residential customers. These price estimates are given in Table 2.1. The price of propane has risen from 10.8 to 16.6 cents per litre over the period from 1975 through 1980. This is an average increase of nine percent per year.

While the prices are interesting they are not very enlightening because of the inflation in energy prices in recent years. Since the different fuels are potential substitutes in many applications, a more useful comparison is the end-use energy cost of each fuel. This comparison is also provided in Table 2.1. Propane has been the most expensive residential energy source.

The comparison of end-use energy prices does not give the complete picture. These costs should ideally be adjusted for the capital and maintenance costs of equipment over its lifetime. Those costs are small relative to the energy costs and will not change the pattern described above.

2.4.2 Propane Prices in the Commercial Sector

The price of propane to commercial customers is again estimated by dividing distributor revenues by the quantity sold to such customers. The estimated price of propane to commercial customers rose from 11.6 cents per litre in 1975 to 17.2 cents per litre in 1980. This is an average increase of about eight percent per year.

Propane prices in the commercial sector are compared to those of other fuels on an end-use basis in Table 2.2. This compensates for the differences in the efficiency of energy use across the fuels. In the commercial sector propane has been more expensive than natural gas. Since 1976, electricity has been 1 to 14 percent more expensive than propane.

TABLE 2.1

ENERGY PRICES IN THE RESIDENTIAL SECTOR

Natural Units

	1975	1976	1977	1978	1979	1980
Electricity (¢/kWh)	1.47	1.77	2.23	2.41	2.54	2.91
Natural Gas (¢/m^3)	5.85	7.63	9.09	10.42	11.48	13.01
Fuel Oil (¢/L)	8.14	9.66	11.02	12.58	14.03	16.85
Propane (¢/L)	10.79	10.74	11.67	12.89	13.42	16.59

End-Use Energy Units

	1975	1976	1977	1978	1979	1980
Electricity ($/GJ)	4.08	4.92	6.19	6.69	7.06	8.08
Natural Gas ($/GJ)	2.62	3.42	4.07	4.66	5.14	5.82
Fuel Oil ($/GJ)	3.24	3.84	4.38	5.00	5.58	6.70
Propane ($/GJ)	7.04	7.01	7.62	8.41	8.76	10.83

Indexed End-Use Energy Cost
(propane = 1.00)

	1975	1976	1977	1978	1979	1980
Electricity	0.58	0.70	0.81	0.80	0.81	0.75
Natural Gas	0.37	0.49	0.53	0.55	0.59	0.54
Fuel Oil	0.46	0.55	0.58	0.59	0.64	0.62
Propane	1.00	1.00	1.00	1.00	1.00	1.00

Notes: Propane price from propane distributors, 0.02553 GJ/L, 60% efficiency

Oil price from Statistics Canada (Toronto price) unpublished document, 0.03868 GJ/L, 65% efficiency

Electricity price from Statistics Canada 57-203, 0.0036 GJ/kWh, 100% efficiency

Natural gas from Statistics Canada 57-205, 37.23 MJ/m^3, 60% efficiency

TABLE 2.2

ENERGY PRICES IN THE COMMERCIAL SECTOR

Natural Units

	1975	1976	1977	1978	1979	1980
Electricity (¢/kWh)	2.40	2.77	3.32	3.52	3.69	4.14
Natural Gas (¢/m^3)	4.50	6.27	7.26	8.39	9.25	10.36
Propane (¢/L)	11.56	11.66	12.43	13.73	13.99	17.23

End-Use Energy Units

	1975	1976	1977	1978	1979	1980
Electricity ($/GJ)	6.67	7.69	9.22	9.78	10.25	11.50
Natural Gas ($/GJ)	2.01	2.81	3.25	3.76	4.14	4.64
Propane ($/GJ)	7.55	7.61	8.11	8.96	9.13	11.25

Indexed End-Use Energy Cost

(propane = 1.00)

	1975	1976	1977	1978	1979	1980
Electricity	0.88	1.01	1.14	1.09	1.12	1.02
Natural Gas	0.27	0.37	0.40	0.42	0.45	0.41
Propane	1.00	1.00	1.00	1.00	1.00	1.00

Notes: Electricity price from Statistics Canada 57-203, 0.0036 GJ/kWh, 100% efficiency

Natural gas price from Statistics Canada 57-205, 37.23 MJ/m^3, 60% efficiency

Propane price from propane distributors, 0.02553 GJ/L, 60% efficiency

2.4.3 Propane Prices in the Industrial Sector

Average propane prices to industrial customers can be calculated from two sources. Statistics Canada reports purchases of fuel and electricity for the industrial sector. This information is the basis for the figures in Table 2.3.

Average prices can also be calculated by dividing distributor revenues by the quantity sold to industrial customers. This approach gives average prices of 10.1 cents per litre in 1975, 15.1 cents per litre in 1979 and 17.4 cents per litre in 1980. These prices are substantially different from those in Table 2.3. We have been unable to determine the reason for the large difference between the two estimates.

The data for all fuels in Table 2.3 are from the same source and hence are presumed to be comparable. On an end-use basis, propane has been substantially more expensive than natural gas. It has become progressively more attractive relative to electricity which is now about 25 percent more expensive than propane.

2.4.4 Propane Prices in the Transportation Sector

Pump prices of gasoline, diesel fuel and propane for transportation use are given in Table 2.4. When the fuel prices are expressed on an energy cost basis, propane is found to have an advantage of at least 20 percent over any other transportation fuel. This advantage has grown over the past year. The comparison in Table 2.4 does not reflect differences in maintenance costs. These will tend to increase propane's advantage over other fuels.

2.4.5 Summary

Estimated average annual propane prices by sector for the past six years are presented in Table 2.5. In all cases the price is estimated by dividing distributor revenue by the quantity sold to customers in the sector.

The price can be substantially different from one sector to another. The crop drying and brooding sectors have the lowest prices, while the commercial and industrial sectors have the highest prices, roughly 20 to 30 percent higher. The price differences reflect, at least partly, differences in the cost of distributing propane to the customer. Propane can be purchased in quantities ranging from 15 litre cylinders to 10 000 litre truckloads. In the latter case the customer has a storage tank and the insurance, labour and delivery costs for the distributor are relatively low per litre of propane. Delivering propane in 15 litre cylinders is much more expensive.

The price of propane in a given area and a given sector reflects the prices of competitive fuels available to the customer.

TABLE 2.3

ENERGY PRICES IN THE INDUSTRIAL SECTOR

Natural Units

	1975	1976	1977	1978	1979
Natural Gas (¢/m^3)	3.42	4.94	5.96	7.08	7.74
Electricity (¢/kWh)	1.20	1.42	1.81	1.89	2.05
LPG (¢/L)	8.46	9.61	10.69	9.90	9.33

End-Use Energy Units

	1975	1976	1977	1978	1979
Natural Gas ($/GJ)	1.14	1.66	2.00	2.38	2.60
Electricity ($/GJ)	3.33	3.94	5.03	5.25	5.69
LPG ($/GJ)	4.14	4.71	5.23	4.85	4.57

Indexed End-Use Energy Cost

(LPG = 1.00)

	1975	1976	1977	1978	1979
Natural Gas	0.28	0.35	0.38	0.49	0.57
Electricity	0.80	0.84	0.96	1.08	1.25
LPG	1.00	1.00	1.00	1.00	1.00

Notes: Prices from Statistics Canada - 57-208

Conversion factors: Natural gas - 37.23 MJ/m^3
Electricity - 0.0036 GJ/kWh
LPG - 25.53 MJ/L

Seasonal efficiencies: Natural Gas and LPG - 80%
Electricity - 100%

TABLE 2.4

DELIVERED ENERGY PRICES IN THE TRANSPORTATION SECTOR

	Gasoline (¢/L)				Diesel	Propane	Gasoline ($/GJ)				Diesel	Propane
	Unleaded		Leaded				Unleaded		Leaded			
	Full Service	Self-Serve	Full Service	Self-Serve	(¢/L)	(¢/L)	Full Service	Self-Serve	Full Service	Self-Serve	($/GJ)	($/GJ)
Jan. 1975			14.6						4.21			
Jan. 1976			18.3						5.28			
Jan. 1977			18.9		19.4				5.45		5.02	
Jan. 1978			20.1		20.1				5.80		5.20	
Jan. 1979			21.7		21.8				6.26		5.64	
Jan. 1980	26.7	25.3	25.1	23.6	24.6		7.70	7.30	7.24	6.81	6.36	
Jan. 1981	33.6	31.8	31.7	29.8	31.0	18.5	9.69	9.17	9.15	8.60	8.01	7.25
Feb. 1981	33.8	31.8	31.7	29.8	31.0	18.0	9.75	9.17	9.15	8.60	8.01	7.05
Mar. 1981	35.9	33.9	33.4	31.7	33.9	18.9	10.36	9.78	9.65	9.15	8.76	7.40
Apr. 1981	36.1	33.9	33.4	31.7	33.9	19.0	10.42	9.78	9.64	9.15	8.76	7.44
May 1981	37.1	34.8	34.4	32.6	35.9	19.1	10.70	10.04	9.92	9.41	9.28	7.48
June 1981	40.1	37.8	37.2	35.2	37.6	19.0	11.57	10.91	10.73	10.16	9.72	7.44
July 1981	40.9	38.3	37.9	35.8	38.4	19.2	11.80	11.05	10.93	10.33	9.93	7.52
Aug. 1981	40.9	38.3	37.9	35.8	39.4	19.3	11.80	11.05	10.93	10.33	10.19	7.56
Sept. 1981	42.2	39.7	39.5	37.2	39.4	19.6	12.18	11.45	11.40	10.73	10.19	7.68
Oct. 1981	42.7	39.9	39.6	37.4	39.7	19.9	12.32	11.51	11.43	10.79	10.26	7.79
Nov. 1981	42.6	39.7	39.6	37.1	40.7	20.0	12.29	11.45	11.43	10.70	10.52	7.83
Dec. 1981	43.3	39.8	40.3	37.2	40.7	20.6	12.49	11.48	11.63	10.73	10.52	8.07

Notes: a) Gasoline prices for 1975 to 1979 are from Statistics Canada, unpublished data file 62F02 on gasoline prices.

b) Gasoline prices for 1980 and 1981 are from Statistics Canada, 1981. Consumer Prices and Price Indexes, 62-010, Oct-Dec.

c) Diesel prices are estimated from data provided by Imperial Oil.

d) Propane prices are calculated by dividing distribution revenue from transportation sales by volume sold.

TABLE 2.5

PROPANE PRICES BY SECTOR

(¢/L)

	1975	1976	1977	1978	1979	1980	1981
Industrial	10.06	11.37	12.83	14.24	15.10	17.35	21.09
Commercial	11.56	11.66	12.43	13.73	13.99	17.23	21.02
Residential	10.29	10.74	11.67	12.89	13.42	16.59	20.60
Crop Drying	8.71	10.45	11.81	10.98	11.62	15.22	18.77
Brooding	9.02	10.30	11.40	12.48	11.20	13.58	17.45
Unclassified	9.73	11.06	12.34	13.71	14.05	17.41	18.68

SOURCE: Calculated from revenues received and volumes sold as reported by propane distributors.

2.5 PROJECTED DOMESTIC WHOLESALE PRICE OF PROPANE

It is impossible to make long-term forecasts of propane prices with any degree of confidence in the uncertain energy pricing environment of the next decade. Since the domestic wholesale price is related to the domestic crude oil price and the NEB minimum export price these two influences are discussed separately.

2.5.1 Domestic Crude Oil Price

In most existing uses propane competes with No. 2 oil. The price of No. 2 oil has been approximately the same as that of crude oil. The wholesale price of propane has been kept below the domestic price of crude oil to ensure that it is competitive with No. 2 oil.

If transportation use becomes the major propane demand, the traditional relationship may change. The price of propane might then be related to that of gasoline. While gasoline is more expensive than crude oil, these two prices are related. This would shift the relationship between domestic propane and crude oil prices from one of approximate parity to one which provides a premium for propane.

The domestic crude oil price is set by the Ottawa/Alberta energy agreement. The schedule of crude oil prices to 1986 as provided by the agreement is presented in Table 2.6. The price of domestic crude oil will increase by roughly 150 percent over the term of the agreement.

It should be noted that the agreement limits domestic crude oil prices to 75 percent of world oil prices in the event that world oil prices rise less quickly than anticipated at the time of the agreement.

2.5.2 The NEB Minimum Export Price

The NEB minimum export price is related to the posted propane price at Mt. Belvieu in such a way as to make Canadian propane competitive with U.S. supplies at St. Paul, Minnesota. The propane price at Mt. Belvieu is approximately related to the price of No. 2 oil and hence the price of crude oil.

This suggests that U.S. propane prices will be related to world crude oil prices. That relationship is likely to be disrupted by the substantial increase in propane production in OPEC countries. As discussed in Chapter 4, a substantial surplus of propane is expected to exist on the world market through the coming decade. This is expected to depress the propane price below that of crude oil.

TABLE 2.6

CANADIAN CRUDE OIL PRICES UNDER
THE OTTAWA/ALBERTA ENERGY AGREEMENT

	¢/L	$/GJ	1980 ¢/L
January 1, 1982	14.78	3.84	12.6
July 1, 1982	16.20	4.21	13.1
January 1, 1983	18.71	4.86	14.4
July 1, 1983	21.23	5.51	15.5
January 1, 1984	23.74	6.17	16.4
July 1, 1984	26.26	6.82	17.2
January 1, 1985	28.78	7.47	17.9
July 1, 1985	31.29	8.13	18.5
January 1, 1986	33.81	8.78	18.9
July 1, 1986	36.32	9.43	19.3

The most recent study of the U.S. Department of Energy contains three projections of the world price of crude oil. The world crude oil price projections are as follows (in 1980 U.S.$/bbl):

	High Case	Medium Case	Low Case
1980	33.50	33.50	33.50
1985	38.50	33.50	25.50
1990	62.50	50.50	36.00
1995	89.50	68.00	42.50

Given the world propane surplus anticipated over the next ten years, the low case is the most reasonable forecast of propane prices. When the low case is converted to propane equivalent the price forecast becomes:

	World Crude Oil Price (1980 C¢/L)	Propane Price (1980 C¢/L)
1980	25.5	17.0
1985	19.4	13.0
1990	27.5	18.3
1995	32.5	21.5

Comparing these figures with those in Table 2.6 indicates that Canadian propane prices are likely to be limited by domestic crude oil prices over the next few years and by world propane prices thereafter.

3. PROPANE MARKETS

3.1 DISPOSITION OF PROPANE

Data on the disposition of propane in Canada and Ontario over the period 1975 through 1980 is given in Table 3.1. The data distinguish propane:

- used as a feedstock for the manufacture of industrial chemicals and other non-energy uses;
- shipped to other provinces
- exported
- used as a source of energy by refineries; and
- sold in domestic markets, primarily as a fuel.

It is important to realize that there is no single, correct source of propane data. Estimates of 1979 propane sales in Ontario are given in both Table 3.1 and 3.2. The figures from different sources are within 10 percent of each other.

3.2 PRODUCER CONSUMPTION AND FEEDSTOCK USE

Propane and other natural gas liquids (NGL's) are separated from crude natural gas by gas plants. These plants use some of the propane as fuel. In 1980, gas plants in Canada consumed about one percent of the propane they produced as fuel. There are no gas plants in Ontario, so propane consumption for this purpose in the province is nil.

Natural gas liquids are separated into their components, including propane, by gas fractionation plants. Oil refineries also produce some propane in the process of converting crude oil into the various petroleum products. In Canada these facilities used about 3.3 percent of the propane they produced as fuel during 1980. Ontario refineries used about 3.7 percent of their propane production as fuel during 1980.

Use of propane as a feedstock is not clearly distinguished by the available data sources. In Statistics Canada data, propane used as a feedstock would show up in a category termed "inter product transfers" if the petrochemical plant was part of an integrated petroleum company. This is reported as non-energy use in Table 3.1. Small amounts of propane not used as a fuel may also be included in domestic sales totals. In Ontario in 1980, use of propane as a feedstock consumed almost 40 percent of the total volume of propane consumed.

TABLE 3.1

ONTARIO AND CANADA PROPANE DEMAND, 1975 - 1980

(ML/yr)

Ontario	1975	1976	1977	1978	1979	1980
Non-energy use[a]	195.4	163.9	155.3	247.8	495.3	333.0
Inter-provincial transfer of refinery production	6.6	0.3	2.9	16.2	38.8	45.6
Exports	1048.4	1457.4	2226.3	1711.8	1662.4	1331.6
Losses[b]	-13.9	9.0	17.5	4.3	16.3	6.5
Use by refineries	13.0	35.0	14.6	16.9	26.0	18.0
Closing inventory	27.1	69.6	24.7	63.1	50.1	22.9
Net delivery to refineries[c]	16.7	6.9	-3.8	45.5	20.8	48.5
Domestic sales	461.6	625.8	688.6	643.7	562.3	422.1
TOTAL	1754.9	2367.9	3126.1	2749.3	2872.0	2228.2

Canada	1975	1976	1977	1978	1979	1980
Non-energy use[a]	226.8	189.6	200.1	296.6	546.1	371.1
Exports	3500.7	3986.8	4799.3	3533.1	4619.6	4068.5
Losses[b]	-12.9	10.6	18.4	6.4	25.9	9.2
Use by refineries	81.1	102.6	57.0	57.0	72.0	46.3
Closing inventory	36.6	78.3	39.0	80.7	66.5	35.6
Net delivery to refineries[c]	10.5	54.0	48.0	57.6	-5.0	43.0
Domestic sales	1120.5	1324.9	1479.4	1559.8	1545.2	1332.6
TOTAL	4963.5	5746.6	6641.2	5591.3	6870.3	5906.3

Notes: a. Non-energy uses are assumed to be inter-product transfers. Other non-energy uses are included in domestic sales but that quantity is relatively small.

b. Losses indicated are refinery losses only.

c. Delivery of goods from companies reporting on the refined petroleum products survey to other reporting companies less receipts by reporting companies.

Sources: Statistics Canada, Refined Petroleum Products. 45-208, Dec. 1975, Dec. 1976, Dec. 1977, Dec. 1978, Jan. 1980, Nov. 1981.

3.3 OVERVIEW OF ONTARIO PROPANE SALES

Several estimates of propane consumption as a fuel in Ontario are available. The estimates for 1979 are compared in Table 3.2. In total, the estimates are within 10 percent of each other. The largest variations are in the data for the industrial and commercial sectors which may be partly due to differences in the definition of these sectors.

Estimated propane use by sector in Ontario from 1975 through 1981 is given in Table 3.3. These figures must be treated as estimates which are accurate to within 10 percent in total, but subject to much larger errors for individual sectors.

Table 3.3 indicates that propane use in Ontario has been relatively stable. There may be some growth, but it is not striking. The consumption pattern also appears to be quite stable; consumption across sectors has not changed much over the past seven years.

Propane accounts for approximately 0.5 percent of Ontario's energy use. It is not a major energy source for any sector.

3.4 PROPANE ENERGY USES

As the data reveal, propane is used in all sectors of the economy. The characteristics that make propane attractive are:

- it burns cleanly so that it can be used indoors and with no risk of contamination of materials being heated; and
- it can be readily transported in cylinders to locations remote from other fuel supplies.

These characteristics give rise to a wide range of applications.

3.4.1 Industrial Sector

Propane is widely used as a fuel for fork lift trucks. Its clean burning characteristics enable the trucks to operate indoors without creating a health hazard for people working in the building; carbon monoxide and hydro-carbon emissions are much lower from propane combustion than from gasoline combustion. The principal competing fuel in this application is electricity. Electricity is more expensive than propane and the electric fork lift trucks are not as powerful as their propane powered counterparts.

In the construction industry, propane is used as a decentralized energy source. Other fuels, especially oil and natural gas, are often not available on construction sites. Propane in cylinders can be delivered where it is needed. It is therefore used for tasks, such as drying drywall or concrete, for which it would be too costly to use electricity.

TABLE 3.2

PROPANE USE IN ONTARIO IN 1979

(ML/yr)

	Statistics Canada [a]	Statistics Canada [b]	NEB [c]	Distributors [d]
Industrial	135.3	197.0	177.8	108.2
Agriculture	108.0	e	108.7	118.2
Transportation	0.2	e	-	e
Residential	185.4	e	171.8	131.0
Commercial	124.4	e	114.6	161.8
Other and unclassified	6.7	e	-	20.6
Total	560.1	e	572.8	539.8

Notes:

a. from Statistics Canada, Quarterly Report on Energy Supply-Demand in Canada. 1979 - IV, Catalogue 57-003.

b. from Statistics Canada, Consumption of Purchased Fuel and Electricity by the Manufacturing, Mining and Electric Power Industries. 1979. Catalogue 57-208. Stated quantity is the sum of reported LPG volumes and thus may include some butane. 57-003 estimates 1979 butane use at 1.8 ML.

c. from NEB, Production Disposition Summary Report as quoted in Government of Ontario, Dome Petroleum Presentation on Propane. 16 May 1980, Attachment 5. This quantity is distributor sales only. In addition, NEB shows 366 ML petrochemical use and 158 ML industrial use.

d. data were collected from propane distributors in Ontario for this study and exclude direct sales to industry. These direct sales are estimated to total 60 to 70 ML per year

e. not estimated

TABLE 3.3

PROPANE USE BY SECTOR IN ONTARIO

(ML/yr)

	1975	1976	1977	1978	1979	1980	1981
Industrial	116.2	126.6	123.1	120.9	108.2	122.3	129.1
Commercial	143.7	159.9	158.1	164.5	161.8	157.1	150.7
Residential	131.7	131.8	128.9	128.4	131.0	129.3	126.9
Agricultural	119.4	107.4	102.4	99.2	118.2	113.6	116.5
Other and unclassified	19.3	17.5	17.5	20.8	20.6	21.7	20.8
Transportation	0.0	0.0	0.0	0.0	0.2	2.9	22.7
Total	530.2	543.1	530.0	533.7	540.0	546.9	566.8

Sources: Transportation data from Stats Can 57-003 for 1979 and 1980.
All other data are distributors' estimates.

Propane is also used extensively in metal cutting torches. Its clean-burning and portability characteristics mean that propane torches can be used anywhere.

3.4.2 Residential and Commercial Sectors

Propane is often used for space heating when natural gas is unavailable because it is less expensive than oil and electricity. It can also be used for hot water heating, cooking stoves and clothes dryers. But its use for these purposes is usually limited to buildings where it is also used for space heating.

Propane is widely used for applications, such as barbecues and camping trailers, where a portable fuel source is desirable.

3.4.3 Agricultural Sector

In the agricultural sector propane is used principally for crop drying, especially tobacco and corn, and poultry brooding. Natural gas, which could be used for these purposes, is often unavailable on farms. Electricity is too costly for such applications. Oil does not burn cleanly and so is dangerous for the chicks and contaminates the crops being dried.

3.5 FORECAST PROPANE DEMAND

3.5.1 Residential Sector

Over the past seven years propane use in the residential sector has declined slightly.

Propane is forecast to be less costly than oil, more costly than natural gas and about the same price as electricity on an end-use energy cost basis. Under these conditions virtually all new residential units will use natural gas if it is available and electricity otherwise. Electricity will be selected over propane because it is cheaper and it is readily available.

The relatively high and rising cost of oil combined with incentives for conversion from oil to other fuels for home heating will increase the demand for propane in existing oil heated homes. Conversion will be to natural gas where it is available, because of the lower cost. Given the construction standards and heating systems in-place in oil heated homes conversion to propane is generally more economic than conversion to electric heating where natural gas is unavailable.

Based on these considerations, the demand for propane in the residential sector is forecast to rise by two percent per year through 1985 as conversions of oil heated homes occur. Thereafter the demand declines by two percent per year as the stock of propane heated homes diminishes and conservation measures are implemented.

3.5.2 Commercial Sector

Propane use in the commercial sector has declined slightly over the past seven years. In this sector, propane is forecast to be less expensive than oil or electricity but more costly than natural gas on an end-use basis.

Under these circumstances, propane use will be limited to areas where natural gas is not available. Conservation measures in both new and existing buildings will reduce energy demand growth in the commercial sector. Propane demand in the commercial sector, reflecting these trends, is forecast to decline at a rate of two percent per year.

3.5.3 Industrial Sector

Propane use in the industrial sector was declining; over the past two years it has grown slightly.

In its principal applications in the industrial sector, propane has advantages over competing fuels. These advantages will prevail given the projected energy prices. On this basis propane demand in the industrial sector is forecast to grow at the same rate as provincial gross domestic product.

3.5.4 Agricultural Sector

In the agricultural sector propane use is limited to a few applications (e.g. brooding and crop drying) where natural gas is unavailable. As the natural gas distribution system is extended, propane use in the agricultural sector will decline. Growth in poultry brooding and crop drying in areas remote from the natural gas distribution system will offset these losses. Overall, propane use in the agricultural sector is forecast to remain constant.

3.5.5 Transportation Sector

Propane use in transportation, apart from the fleets of propane distributors, is a new development in Ontario. Its use in this application has grown rapidly since the removal of the provincial road tax from propane and other alternative transportation fuels. Propane now has a substantial cost advantage over gasoline and diesel fuel. This cost advantage is assumed to be maintained.

A recent study of alternative transportation fuels in Ontario found that propane will be the preferred alternative fuel over the next fifteen years.[1] That study developed high and low scenarios of demand for alternative transportation fuels. The projected number of propane vehicles in the low scenario was 17 500, 87 000 and 244 800 vehicles in 1985, 1990 and 1995 respectively. With a high penetration rate, it was estimated that the number of propane vehicles would be 286 900, 1 112 500 and 1 155 400 in 1985, 1990 and 1995 respectively.

To assess the propane supply situation in Ontario the high scenario has been adopted. The high transportation demand for propane has two components; commercial fleets with more than 20 vehicles and small fleets and private cars. Propane is assumed to be used by 25 percent of new automobiles in small fleets and private fleets from 1985 through 1995. Propane use in commercial fleets is projected to decline from 100 percent in 1985 to 80 percent in 1990 to 20 percent in 1995. This decline is due to competition from other alternative transportation fuels.

The demand for propane is calculated by combining the fuel efficiency and useage pattern for each type of vehicle. These unit demands are then multiplied by the number of vehicles of each type using propane, and propane demand is summed for all types of vehicles. The resulting propane demand in the high scenario is 751.7 ML, 2 671.2 ML and 2 139.8 ML in 1985, 1990 and 1995 respectively. This is a dramatic increase over the 1980 use of 2.9 ML and estimated 1981 use of 22.7 ML.

3.5.6 Petrochemical Use

No growth is expected in the use of propane as a feedstock in Ontario. New petrochemical plants will most likely be located in Alberta.

3.5.7 Propane Demand in Ontario

The forecast propane demand in Ontario is summarized in Table 3.4. The demand is forecast to more than double over the coming decade. All of the growth is due to the increased use of propane as a transportation fuel.

---

1. Middleton Associates, Mueller Associates, Inc., 1981. Alternative Transportation Fuels Utilization Review, prepared for the Ontario Ministry of Transportation and Communications.

TABLE 3.4

FORECAST ONTARIO PROPANE DEMAND

(ML/yr)

	1980	1985	1990	1995
Residential	129.3	142.8	129.0	116.6
Commercial	157.1	142.0	128.4	116.0
Industrial	122.3	128.6	134.3	138.9
Transportation	2.9	751.7	2671.2	2139.8
Agriculture	113.6	115.0	115.0	115.0
Sub-total	525.2	1280.1	3177.9	2626.3
Unclassified and other	21.7	52.9	131.3	108.5
Total Energy	546.9	1333.0	3309.2	2734.8
Petrochemical Use	333.0	300.0	300.0	300.0
Total Demand	879.9	1633.0	3609.2	3034.8

Note: Derivation of numbers is discussed in the text.

3.6 MARKETS FOR ONTARIO PROPANE IN THE UNITED STATES

3.6.1 Existing Markets

In 1980, Canada exported 4068.5 ML of propane, or over 65 percent of total demand. This is about 10 percent of the total U.S. demand for propane. Ontario exports to the United States amounted to 1331.6 ML, or 32.7 percent of total Canadian exports. Exports of propane from Ontario to the United States have been decreasing over the last four years as indicated in Table 3.5.

TABLE 3.5

PROPANE EXPORTS (ML/YR)

Year	Ontario Exports	Canadian Exports	Percent of Canadian exports from Ontario
1975	1048.4	3500.7	29.9
1976	1457.5	3986.8	36.6
1977	2226.3	4799.3	46.4
1978	1711.8	3533.1	48.5
1979	1662.4	4619.6	36.0
1980	1331.6	4068.5	32.7

Within the United States, propane use is documented by Petroleum Allocation District (PAD). The largest propane using PAD is PAD2, which includes the states from North Dakota south to Kansas and east to Ohio. Oklahoma, Tennessee and Kentucky are also included in this PAD. Canadian exports in this PAD provide 20 percent of the propane use in this district. Unfortunately, it is impossible to distinguish between exports from Ontario and Alberta because of the extensive U.S. pipeline network. PAD1, which consists of all states east of PAD2 (including Florida) gets about 10 percent of its propane from Canada.

Within the United States, propane use is disaggregated into six categories:

- residential and commercial
- internal combustion engine fuel (highway vehicles, forklift trucks, industrial tractors and oil field drilling engines)
- industrial uses
- gas utility use
- chemical use
- miscellaneous uses including all farm uses

Propane use within these six categories is illustrated in Figure 3.1. The residential and commercial category uses the most propane. Uses in this category include heating, cooking, water heating, clothes drying and incineration in non-farm private households. Also included are sales to non-manufacturing establishments such as motels, restaurants, retail businesses, laundries and other service enterprises, primarily for use in space heating, water heating and cooking.

3.6.2 Future markets

Projections of future propane demand in the United States, as in Canada, are complicated by three main factors:

- the propane market is small relative to the oil and natural gas markets, with which is competes
- the price of petroleum products has changed rapidly in the U.S. in recent years, creating an unstable environment in which decisions by propane users cannot be forecast with confidence
- the supply of propane is uncertain

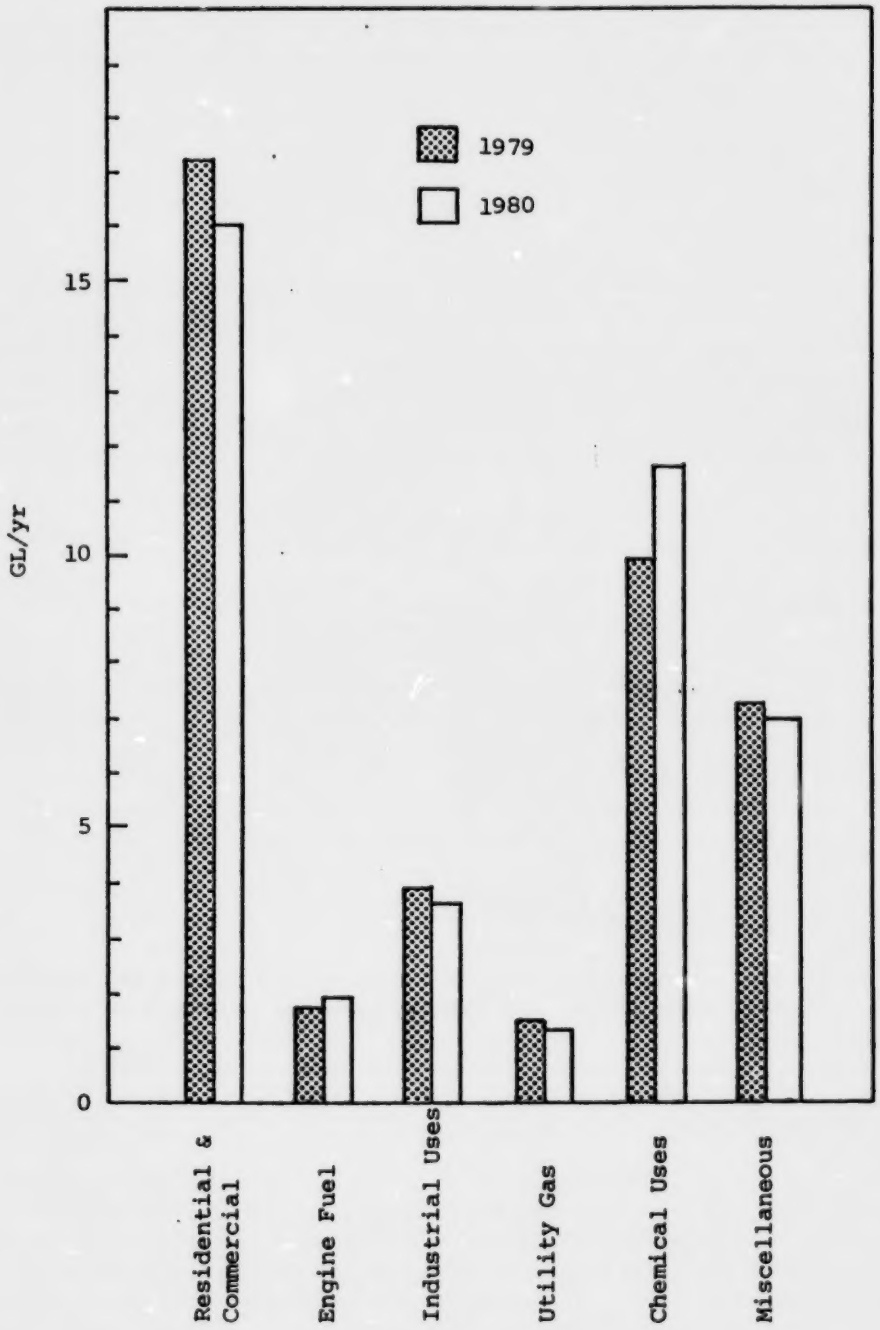
Since Ontario is concerned with the size of the import market to the United States, both demand and supply from U.S. sources are considered.

U.S. Propane Demand

The demand for propane in almost all sectors is expected to increase. The only exception is the residential sector. Although forecasts prepared in 1980 showed an increase in residential use, more recent projections show a gradual decline of about 0.3 percent per year. This change is a result of conservation resulting from both higher prices and government subsidies for upgrading insulation and using efficient furnaces, water heaters and appliances.

FIGURE 3.1

U.S. SALES OF PROPANE ACCORDING TO PRINCIPAL USES



Source: Compilation of Data from the U.S. DOE Energy Information Administration

The use of propane for industrial purposes is expected to grow only moderately. Recently, the improved availability and relatively low price of natural has dampened the prospects for generally increased industrial consumption of propane. Propane is still considered as an alternate fuel by industry should supplies of natural gas be diverted to residential customers during periods of very cold weather.

The use of propane as a motor fuel in the United States is currently increasing rapidly and will be expected to continue to do so if the current price advantage of propane over gasoline persists. A 7.4% growth rate in the 1980s is projected. The recent announcement by Ford and International Harvester of new dedicated propane-fueled cars and trucks should stimulate the demand for propane for this use. One factor that may slow the growth in the demand for propane vehicles is the increasing fuel efficiency of cars and trucks in an environment of stable or declining gasoline and diesel fuel prices.

The use of propane as a feedstock in petrochemical production is expected to increase slowly throughout the 1980s. Ethylene production can be based on propane or naptha. Supplies of naptha for this purpose are expected to fall as more and more naptha is upgraded to gasoline.

U.S. Propane Production

As in Canada, the two sources of propane in the United States are production by refineries and gas processing plants. Production from refineries is expected to be fairly constant but gas plant production will decline. The decline is due primarily to reduced natural gas production within the continental United States.

Import Demand

Table 3.6 presents the projected demand through 1990 and the supply of propane from United States production. The difference between the two is the demand for imported propane. As the table indicates, the need for imports is expected to increase rapidly from 6960 ML in 1982 to 20 730 ML in 1990.

The geographic distribution of propane consumption is expected to change and this may have some influence on the attractiveness of Canadian propane. Historically, use of propane was concentrated in the U.S. farm belt; the engine fuel market and gas utilities market are widely dispersed throughout the U.S. The chemical feedstock market is centred around the existing ethylene plants on the Gulf Coast, close to import terminals for overseas propane. Considerable interest has been displayed in developing new propane terminals at the Gulf Coast with access to pipelines for moving propane to inland storage areas.

TABLE 3.6

UNITED STATES IMPORT REQUIREMENT FOR PROPANE

(GL/yr)

	1982	1985	1990
U.S. Demand			
Residential/Commercial	24.76	24.56	24.17
Industrial Use	9.36	9.46	10.15
Engine Fuel	4.52	6.49	8.35
Chemical Feedstocks	9.53	9.83	10.12
Other	3.61	4.20	7.05
TOTAL	51.78	54.54	59.84
U.S. Production			
Gas Plants	28.10	25.55	23.19
Refineries	15.72	15.82	15.92
TOTAL	43.82	41.37	39.11
U.S. Import Requirements			
Demand - Production	7.96	13.17	20.73

SOURCE: Lewis, Anthony C., "North America's Propane Supply Outlook", Butane-Propane News. January 1982, pp. 19-23.

With improved and increased numbers of import terminals for overseas propane, the demand for Canadian propane is likely to be determined by the competitiveness of its price, not the overall demand and supply situation. As discussed in greater detail in the next chapter, global propane supply is likely to be abundant. That means that Canadian propane exports will be subject to stiff competition.

4. PROPANE SUPPLY

Canada currently exports over 65 percent of its propane production to the United States. This suggests that there are ample supplies to support an expansion of propane demand. On the other hand, most of the propane used in Ontario is imported. To assess the propane supply available to Ontario it is necessary to examine future Canadian supplies and other demands, including exports, that may be placed on them.

4.1 WORLD LPG TRADE

4.1.1 Exports

Tables 4.1 and 4.2 present two projections of world LPG exports over the next decade. The magnitudes are different, but the message is the same. Exports of LPG's will increase by about 50 percent over the next decade. All of this increased supply will come from OPEC countries in North Africa and the Middle East.

In the past the LPG's were flared or reinjected into the reservoirs. Facilities to recover the LPG's are currently under construction. When these facilities go into service over the next few years, the supply of propane and other gas liquids on the world market will increase sharply.

4.1.2 Imports

Forecast imports of LPG's over the coming decade are shown in Table 4.3. Imports are projected to double over this period.

The major importing countries are Japan and the United States. Japan accounts for over half of all LPG imports. The U.S. imports are expected to remain in the order of 20 percent of total imports.

4.1.3 World Surplus

Tables 4.4 and 4.5 present two estimates of the world surplus of LPG over the next decade. Again the magnitudes are different, but the conclusion is the same. The conclusion is that there will be a substantial world surplus of propane over the next decade. In 1985 the surplus is equivalent to at least 25 percent of world demand.

TABLE 4.1

WORLDWIDE EXPORTABLE LPG SURPLUS

(GL/yr)

Exporting Countries	1982	1985	1990
OPEC			
Middle East	30.52	43.79	43.21
Africa	2.61	9.15	23.73
Far East	0.78	0.64	0.32
America	1.75	2.42	1.76
NON-OPEC			
Central & South America	1.50	2.64	3.65
Comercon Countries	0.53	0.53	0.53
Canada	7.86	6.40	2.76
North Sea	5.22	6.42	8.41
Middle East	0.39	0.30	0.16
Australia	2.57	2.87	2.60
Far East	0.34	0.37	0.55
TOTAL	54.07	75.53	87.68

SOURCE: A. Showail, Saudi View of LPG Industry. Presented at Gastech Conference, Hamburg, Germany, October, 1981.

TABLE 4.2

WORLDWIDE LPG EXPORT AVAILABILITY

(GL/yr)

	1985	1990
Middle East	34.0 - 39.0	42.0 - 48.0
Latin America	4.5 - 5.5	6.0 - 9.0
Africa	7.0 - 9.0	10.0 - 12.5
North Sea	4.5 - 5.5	5.5 - 5.5
Far East	2.7 - 3.2	4.5 - 1.0
Various	0.9 - 2.1	3.5 - 4.5
TOTAL	53.5 - 64.0	71.0 - 84.0

SOURCE: LPG Supplies in Spain in the Decade 1980 - 1990. Presented at the U.N. Symposium, Dublin, Ireland, October, 1981.

TABLE 4.3

WORLD PROPANE IMPORT DEMAND

(GL/yr)

Importing Region	1982	1985	1990
U.S.A.	6.94	9.75	16.97
S. Europe	3.17	2.92	3.60
N. Europe	3.82	5.78	10.07
Japan	21.18	32.46	41.00
Asia	0.50	1.28	2.16
Other America	0.12	0.25	0.82
Africa	0.62	0.48	0.96
TOTAL	36.74	52.93	75.58

SOURCE: A. Showail, Saudi View of LPG Industry. Presented at Gastech Conference, Hamburg, Germany, October, 1981.

TABLE 4.4

WORLDWIDE SURPLUS AVAILABLE FOR NEW MARKETS

(GL/yr)

	1982	1985	1990
Potential Exports	54.07	75.57	87.71
Potential Imports	36.74	53.29	75.59
Potential Surplus for New Markets	17.33	22.28	12.12

SOURCE: A. Showail, Saudi View of LPG Industry. Presented at Gastech Conference, Hamburg, Germany, October, 1981.

TABLE 4.5

LPG SUPPLY/DEMAND BALANCE
IN NON-COMMUNIST WORLD

(GL/yr)

	1985	1990
Supply		
OPEC	64.36 - 66.68	66.50 - 75.77
Other	5.70 - 6.60	6.60 - 8.38
TOTAL	70.06 - 73.28	73.10 - 84.15
Demand		
Western Europe	3.57 - 5.35	4.81 - 9.81
U.S.A.	8.56 - 17.47	16.94 - 28.70
Japan	28.52 - 33.87	39.22 - 41.00
Other	2.14	2.32
TOTAL	42.79 - 58.83	63.29 - 81.83
Surplus (Deficit)	11.23 - 30.49	(8.73)- 20.86

By 1990 the surplus is somewhat reduced in both absolute and relative terms, but continues to exist.

It has been suggested that OPEC countries may tie sales of LPG's and crude oil. This is one means of disposing of their LPG production at a time when a world surplus exists. Even if this happens the LPG's ultimately need to reach markets where they can be used. One of the attractive markets will be the United States, since it is already a large market and has in place a substantial infrastructure suitable for receiving, storing, transporting and distributing LPG's.

The United States will be one of the "dumping grounds" for the surplus LPGs over the next decade. This will increase the competition Canadian propane exports face in the American market. The effect will be to increase the availability of Canadian and/or world propane supplies to Ontario.

4.2 CANADIAN PROPANE SUPPLIES

4.2.1 Existing Supplies

The sources of propane supply in Canada for the period 1975 through 1980 are summarized in Table 4.6. The principal source of propane is gas plant production. This source accounts for over three-quarters of the total propane supply. Almost all of the rest is produced by petroleum refineries. Imports are negligible.

4.2.2 Future Canadian Propane Supply

In late 1980 and early 1981, the National Energy Board held hearings into Canadian energy supply and demand for the 1980 to 2000 period. Propane and other gas liquids were among the energy sources evaluated. Submissions on propane supply were made by Dome, Gulf, Imperial, the Province of Ontario, Petro-Canada, Shell and the Propane Gas Association of Canada. The uncertainty of future propane supplies is reflected in the range of forecasts in the submissions.

Forecasts of production by gas plants by three of the submittors, along with the forecast of the Board are presented in Figure 4.1. Petrocan predicted the greatest supply through 1986; Dome's forecast was highest after 1986. At the low end of the range was Imperial Oil's submission through 1984. Forecasts presented by the Ontario Ministry of Energy were lowest for the 1984 to 1987 and post 1992 periods. The National Energy Board's forecast was the lowest for 1987 to 1992.

TABLE 4.6

PROPANE SUPPLY IN CANADA 1975 - 1980

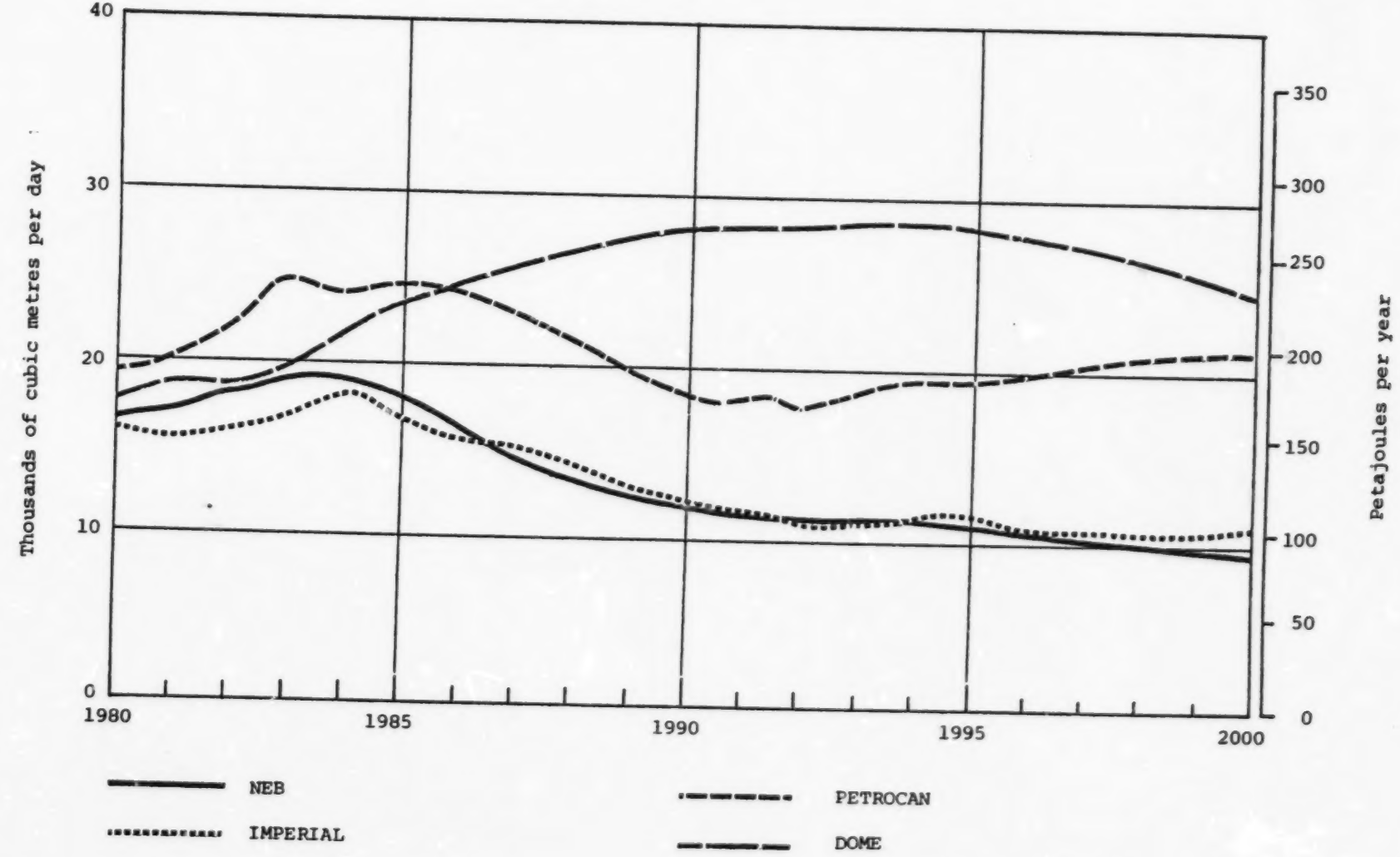
(ML/yr)

Canada	1975	1976	1977	1978	1979	1980
Refinery production	1090.7	1241.7	1338.0	1571.3	1546.1	1419.2
Gas plant production*	3809.5	4467.1	5224.2	3980.1	5243.9	4420.5
Imports	0.6	1.2	0.7	0.9	0.0	0.0
Opening inventory	62.7	36.6	78.3	39.0	80.7	66.5
Total	4963.5	5746.6	6641.2	5590.3	6870.7	5906.3

*Receipts from non-reporting companies plus total propane exports minus exports of refinery produced propane. Quantity is net production after accounting for own consumption and losses.

Source: Statistics Canada, Refined Petroleum Production. 45.208, December 1975, December 1976, December 1977, December 1978, January 1980, November 1981.

FIGURE 4.1: FORECASTS OF CANADIAN PROPANE SUPPLY



Refinery Production

The range of forecasts for refinery production is much narrower. At the top of the range through 1988 was Imperial who predicted 4.5 ML/day through 1983 rising to 5 ML/day by 1985. The Gulf forecast reaches 5 ML/day in 1988 and 5.3 ML/day by 1990, after which it is constant. The low end of the range fluctuates between 3.8 ML/day and 4.3 ML/day.

Production from Synthetic Crude Oil Plants

Two new sources of propane supply may become available by 2000: synthetic crude oil plants and frontier areas. Gulf forecasted the largest supply from synthetic crude oil plants at about 670 ML/year by 1989 from the Syncrude, Alsands and Cold Lake plants. Other submittors suggested that net production from synthetic crude plants was improbable.

Production from Frontier Areas

Some submittors indicated potential production from frontier areas. Although production from the Beaufort and the Arctic Islands is not expected, there is potential for getting propane from the Mackenzie Delta, and the Scotian Shelf. Imperial projected production levels of 245 ML for 1992 rising to 525 ML in 1994 from the Mackenzie Delta. Imperial also projected Sable Island production of 140 ML in 1988 and 280 ML in 2000. Mobil projected a production rate from the Scotian Shelf of 67 to 78 cubic metres of propane per million cubic metres of gas.

Total Production

Table 4.7 presents the National Energy Board's forecast of propane production through 2000. The Board's base forecast excludes production from frontier areas. There is some doubt whether the frontier projects will proceed. Even if they do it can be seen from Table 4.7 that they will not have a major impact on Canadian propane supplies.

4.2.3 Canadian Demand-Supply Balance

The National Energy Board projected four categories of demand for LPG's: petrochemical, commercial-residential-industrial, transportation and use by the energy supply industry. In the petrochemical industry, the Board projected one world-scale petrochemical plant using propane as a feedstock would come on stream in 1990. The propane demand of this plant would be 2 GL/yr. In view of the world surplus of petrochemicals and activity in the Middle East, it must be questioned whether it is reasonable to include this plant in the demand forecast.

TABLE 4.7

NEB FORECAST OF PROPANE PRODUCTION

(ML/yr)

	CONVENTIONAL SOURCES			FRONTIER AREAS		
	Gas Plants	Refineries	Total	Mackenzie Delta	Scotian Shelf	Total
1981	5 810	1 330	7 140			
1982	6 195	1 365	7 560			
1983	6 335	1 365	7 700			
1984	6 475	1 365	7 840			
1985	6 265	1 365	7 630			
1990	4 270	1 400	5 670		140	140
1995	3 710	1 470	5 180	525	245	770
2000	3 360	1 540	4 900	525	280	805

SOURCE: Canadian Energy Supply and Demand 1980-2000. National Energy Board, Ottawa, June 1981, pp. 184-187.

The Board projected growth of LPG in the commercial, residential and industrial sectors to grow at 0.8 percent per year. Much of this growth could be expected to be in the Maritimes where natural gas is unavailable. It has been assumed that this rate applies to both butane and propane.

Transportation demand was projected to grow by 14.1 percent per year as a result of incentive programs such as are currently operating in Ontario.

Use of LPG by the energy supply industry was expected to grow to 6.4 times current levels by 2000. It has been assumed that the growth is linear and applies equally to propane and butane.

The total Canadian forecast is presented in Table 4.8. Since the NEB transportation forecast is lower than the Ontario transportation demand projected in Chapter 3, the NEB forecast has been adjusted by subtracting 1980 Ontario demand from each year and adding the projected demand for each forecast year from the Ontario demand projection in Chapter 3.

4.3 ONTARIO PROPANE SUPPLY

4.3.1 The Existing Supply Situation

There are four sources of propane in Ontario:

- refinery production within Ontario
- refinery production in other provinces
- gas plant production in other provinces
- imports

Propane is produced by oil refineries. Five oil refineries operate within Ontario. In 1980, these five refineries produced 34.3 percent of the total Canadian production of propane by refineries.

Small quantities of propane produced by refineries in Quebec are brought into Eastern Ontario. In 1980, propane from this source totalled about 0.4 ML. In addition, small amounts of propane may be imported from the United States. In recent years, however, there has been no propane imported into Ontario.

By far the largest source of propane in Ontario is propane produced by gas processing plants in Alberta. In 1980, this source of propane provided 76.9 percent of the total quantity of propane coming into the province.

TABLE 4.8

CANADIAN PROPANE DEMAND

(ML/yr)

	1980	1985	1990	1995
Existing Petrochemical	400	400	400	400
New Petrochemical	-	-	2000	2000
Commercial/Residential/ Industrial	1300	1400	1450	1500
Transportation	25	50	100	180
Energy Supply Industries	40	50	60	70
NEB Canadian Demand	1800	1900	4000	4200
1980 Ontario Demand	900	900	900	900
Projected Ontario Demand	900	1600	3600	3000
Projected Canadian Demand	1800	2600	6700	6300

Table 4.9 presents the quantity supplied by each source for 1975 through 1980. Annual fluctuations are caused by fluctuations in the production of petroleum and natural gas from which LPG's, including propane, are extracted.

4.3.2 Future Propane Supply

Given the broad range of assumptions and projections of both propane demand and supply that have been given by producers, the cautious approach to an analysis of Ontario's future propane supply situation is to compare a high demand projection with a low supply projection. If that situation is manageable, the propane supply will be adequate for all circumstances.

The conservative estimate of Canadian propane supply is presented in Table 4.7. The optimistic estimate of Canadian propane demand is given in Table 4.8. It incorporates the high estimate of transportation demand in Ontario. Comparing these estimates indicates a surplus of 5 030 ML in 1985, and deficits of 1 030 ML and 1 120 ML in 1990 and 1995, respectively.

The deficits indicated for 1990 and 1995 suggest potential supply difficulties for Ontario. Supply difficulties, however, are very unlikely for several reasons.

- Transportation demand projection is high. Transportation demand was estimated using a very high penetration rate. The Ministry of Energy has set a target propane vehicle market in 1985 of 40 000. This is less than 14 percent of the number of vehicles used in this analysis for the same year.

- Canadian demand projection may be high. Canadian demand was estimated by subtracting the 1980 Ontario demand from each year and adding the projected Ontario demand. The NEB demand projections included growth in demand in Ontario, and thus the projected Canadian demand is somewhat inflated.

- Petrochemical demand projection may be high. The Canadian demand projection includes a large new propane based petrochemical plant that will require 2 GL of propane in 1990 and 1995. If this plant is not built, as now seems probable, the propane deficit is eliminated and there is a surplus of 970 ML in 1990 and 880 ML in 1995.

- Supply projections used are low. The supply projections used are low. In both 1990 and 1995, the NEB forecasts of supply are only about 40 percent of Dome's projected supply. Since the NEB hearings, several firms have increased their projected supply.

Even if the calculated deficits materialize they can be managed by the use of propane/butane mixtures for transportation use. Although butane is not substitutable in traditional propane markets, butane-propane blends are quite feasible in the transportation market. Table 4.10 indicates the percentage of butane in LPG used for transportation in other countries. Although problems may result when butane is used at low temperatures, it is in the summer that butane is in greater supply since its use in gasoline is decreased.

In 1980, Canada exported 2 296 ML of butane, or 47.6 percent of total production. Since even the highest submission to the Board had a growth rate of 2.5 percent per year, there should be a surplus of butane of about 3 800 ML in 1985, 2 500 ML in 1990, and 2 100 ML in 1995.

Even under rather conservative assumptions, the combined propane butane supply available to Ontario is sufficient to satisfy the projected propane demand through 1995.

TABLE 4.9

PROPANE SUPPLY IN ONTARIO 1975 - 1980

(ML/yr)

Ontario	1975	1976	1977	1978	1979	1980
Refinery production	353.3	403.6	404.7	567.0	523.2	486.7
Inter-provincial transfer of refinery production	10.4	1.9	0.4	3.8	0.1	0.4
Inter-provincial transfer of gas plant production*	1347.9	1934.6	2650.7	2153.1	2285.7	1691.0
Imports	0.6	0.8	0.7	0.7	0.0	0.0
Opening inventory	42.5	27.1	69.6	24.7	63.1	50.1
TOTAL	1754.7	2368.0	3126.1	2749.3	2872.1	2228.2

*Receipts from non-reporting companies plus total propane exports minus exports of refinery produced propane. Quantity is net production after accounting for own consumption and losses.

Source: Statistics Canada, Refined Petroleum Products. 45-208, December 1975, December 1976, December 1977, December, 1978, January 1980, November 1981.

TABLE 4.10

COMPOSITION OF LPG SOLD AS AUTOMOTIVE FUEL IN EUROPE

	Percentage of Propane	Percentage of Butane
W. Germany	90	10
France	35	65
Italy	20	80
Netherlands	40 - 50	60 - 50
Belgium	50 - 60	40 - 50
Austria	50	50
Sweden	95	5
Denmark	50	50
U.K.	100	-

SOURCE: Shell International

5. TRANSPORTATION AND DISTRIBUTION OF PROPANE

The cost of transporting propane from Alberta to Ontario is a significant part of its wholesale price. For example, propane purchased at 9.33 cents per litre F.O.B. Edmonton in March 1982 would incur rail freight charges of 5.07 cents per litre for shipment to Toronto. The transportation costs, are 35 percent of the delivered cost to the wholesaler.

5.1 PROPANE TRANSPORTATION

5.1.1 The Existing Transportation System

Propane from Alberta reaches Ontario in one of two ways. Propane can be purchased from fractionation plants in Alberta and delivered to distributors or large industries in Ontario by rail. A modern rail tank car holds about 115 000 litres. Relatively little propane is shipped to Ontario in this manner, mostly to western parts of the province.

Most of the propane delivered to Ontario is shipped in the form of natural gas liquids via the Interprovincial Pipeline system. Dome Petroleum collects natural gas liquids from about forty gas processing plants in Alberta. The liquids are shipped to Dome's fractionation plant in Sarnia via the Interprovincial Pipeline system. The Interprovincial Pipeline is primarily used to ship crude oil from western Canada to Ontario, but the shipment of natural gas liquids via the pipeline poses no problems.

The volume of natural gas liquids shipped via the pipeline is in the order of 20 million litres per day. This represents approximately 9 million litres per day of propane after fractionation. The bulk of Ontario's propane supplies are received in this way.

Propane demand is seasonal with sales during the winter months being roughly triple those during the summer months. To accommodate the seasonal peak, Dome has natural gas liquids storage facilities in the west and over 600 million litres of product storage capacity in the Sarnia area.

Propane is shipped from the Dome fractionation plant to distributors and large customers by rail tank car or tank truck. Rail shipment is generally used for distances over 400 km (areas east of metropolitan Toronto). Tank trucks each carrying about 45 000 litres are used to transport the propane over shorter distances.

Propane consumed in Ontario is also obtained from oil refineries in Ontario and Montreal. In total about ten percent of the propane received in Ontario comes from this source. The propane is shipped from the refineries to distributors and large customers by tank truck.

5.1.2 Possible Developments in the Transportation System

The lowest cost mode of transporting large quantities of propane is by pipeline. The key to expansion of propane consumption in Ontario is pipeline capacity for propane shipment from Alberta to Ontario. Several options exist:

- additional quantities of natural gas liquids could be shipped via the Interprovincial Pipeline to the Dome fractionation plant in Sarnia. The Dome plant is now operating at approximately 75 percent of capacity.

- propane from fractionation plants in Alberta could be shipped in batches to Sarnia via Interprovincial Pipeline's number two pipeline. This would require some modifications of the number two pipeline. Imperial Oil has filed an application with the Alberta Energy Resources Conservation Board to transport propane to Ontario in this manner.

- propane from fractionation plants in Alberta could be shipped in batches to Sarnia via the Cochin Pipeline. This pipeline is controlled by Dome but is a public carrier. It is, however, booked to capacity until 1985 transporting ethane and ethylene to the SNG plant in Green Springs, Ohio and Dome's petrochemical plant in Michigan.

The routes of the Interprovincial and Cochin Pipelines are shown in Figure 5.1.

Increased propane shipments to Sarnia will require expansion of the storage facilities. The storage facilities will not need to be expanded in proportion with the quantities shipped. The growth in propane consumption will be for transportation use which has a summer peak. The traditional markets have a winter peak.

As the quantity of propane consumed in Ontario grows, it may also be feasible to use existing petroleum product pipelines for distribution within the province. Existing pipelines that could be used for propane shipment are shown in Figure 5.2. These pipelines run from Sarnia east to Toronto, Ottawa and Montreal.

FIGURE 5.1

NATURAL GAS LIQUID TRANSMISSION PIPELINES

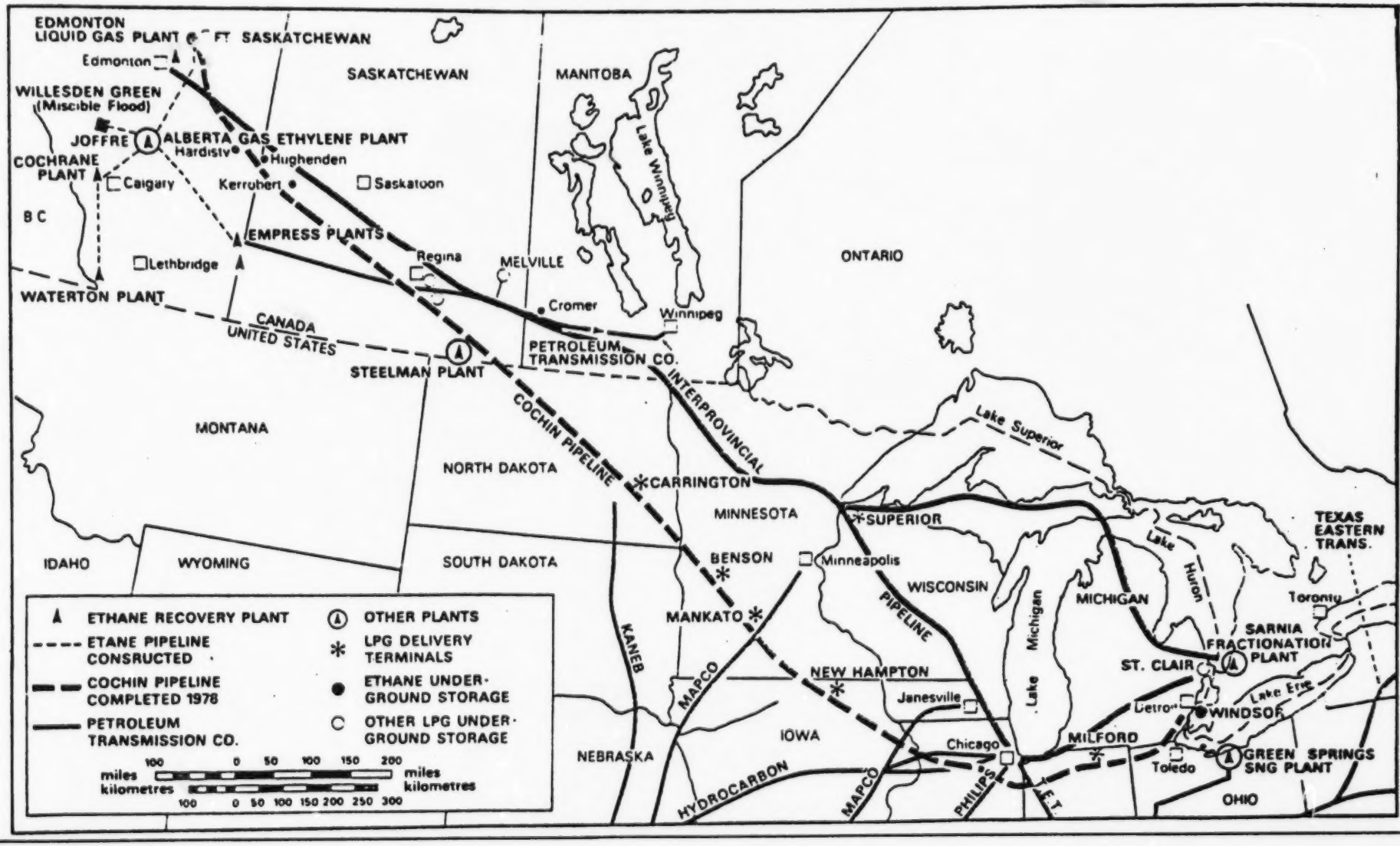


FIGURE 5.2

EXISTING OIL PRODUCT LINES THAT
COULD BE USED FOR PROPANE SHIPMENT

Pipeline shipment of propane would require construction of receiving stations at appropriate points on the pipelines. Much larger quantities than are currently used in Ontario are needed to make construction of these facilities for pipeline shipment economically attractive.

5.2 PROPANE DISTRIBUTION

5.2.1 The Existing Distribution System

As discussed above, propane is transported in bulk to bulk distribution outlets. Currently, there are 73 bulk propane plants in Ontario. The locations of these plants are listed in Table 5.1. It shows that these distribution centres cover most of the province.

The propane distributor delivers propane to retail customers in one of three ways:

- a bobtail (i.e. tank truck) to a storage tank installed on the customer's premises.
- a delivery truck drops off cylinders filled with propane and collects empty cylinders.
- the customer brings a cylinder to a station to be refilled.

The first method applies to most of the propane used in Ontario. Residential, commercial, industrial and agricultural customers generally have storage tanks which are refilled from bobtails. Residential and commercial customers have storage tanks with capacities ranging up to 1500 L. Agricultural and industrial customers may have larger storage tanks.

Cylinder delivery is generally used for fork lift truck, welding and construction uses. The cylinders typically have a capacity of about 30 L.

Propane for use in camping trailers, barbecues and similar applications is generally obtained by having the customer bring the cylinder to a station to be refilled. These cylinders typically have a capacity of 15 L.

5.2.2 Future Distribution Requirements

To meet the projected demand for propane, rapid expansion of the distribution system will be required. The growth in demand is for transportation. The existing distribution system is a constraint on the growth of propane use in this sector. The distribution system will need to be expanded to accommodate the transportation demand.

TABLE 5.1

ONTARIO BULK PROPANE PLANTS

Alliston
Aylmer
Baden*
Bala
Bancroft
Barrie
Belleville
Blind River
Brampton*
Cambridge*
Carleton Place
Cayuga
Chatham (2)
Concord
Cornwall (2)
Echo Bay*
Elliott Lake
Fenelon Falls
Fort Frances
Goderich*
Grand Bend
Guelph (2)
Hamilton
Hawkesbury
Ignace*
Kenora
London
Keswick*
Kingston
Manitouwadge
Markham
Milton
Moosonee
New Liskeard*
Newboro
North Bay
Long Lac
Ottawa (2)
Owen Sound
Parry Sound
Pembroke
Peterborough (2)*
Porcupine
Prescott
Putnam
Sarnia (3)**
Sault Ste. Marie
Simcoe Smithville
Stratford (2)*
Strathroy
Sudbury (2)
Thunder Bay (2)
Timmins
Vermillion Bay
Walkerton
Washago
Wawa
Weston
Whitby
White River
Windsor
Woodbridge*

TOTAL: 73

*Plant installed since 1975.

Propane for transportation use, whether fleets or private vehicles, will be dispensed from a bulk storage tank at a refilling station. The storage tank will have a capacity ranging between 7 500 and 15 000 L. The propane is pumped to a refuelling island where it is metered and dispensed to the vehicle. The locations of the storage tank, refuelling facilities, and emergency valves are governed by safety regulations.

6. PROPANE SAFETY

6.1 INTRODUCTION

Safety is an important concern for any fuel system. Propane is no exception. It is a flammable substance in both the liquid and vapour state. Certain propane/air mixtures are explosive.

The concern about propane safety relates more to the severity of the accidents that occur than to their frequency. Among the well publicized accidents involving propane over the past several years are:

- Mississauga train derailment, 1980.
- transport truck accident near San Carlos de la Rapita, Spain in 1978 in which 156 people were killed.
- transport tuck accident near Eagle Pass, Texas in 1975 where 16 people were killed by the explosion and fire.

These examples illustrate that the most severe accidents involve bulk transportation of propane.

Virtually every aspect of propane transportation, storage and distribution is regulated with respect to safety. At best, regulations reduce the incidence and severity of accidents. They cannot eliminate accidents. The regulations and risks associated with propane use are reviewed in the following sections.

6.2 SAFETY REGULATION

6.2.1 General Regulation

The primary standard governing propane safety in Canada is the Canadian Standards Association Code B149.2. This code deals with the marking of tanks and cylinders; the storage, handling, transfer, and transportation of propane as a cargo or a fuel source; and maximum capacity standards and minimum buffer zone distances for cylinders and tanks. It also deals with the installation of propane systems, equipment protection standards with special emphasis on safeguarding against mechanical damage, venting, safety standards, testing, and the proper procedures regarding product transfers and repair work.

Code B 149.2 can be considered a minimum requirement for safety. The safety standards of a number of companies, and some provinces, are much more stringent than Code B149.2.

Propane is handled more frequently by individuals at cylinder refilling and distributor outlets than at any other stage from the producer to the consumer. With more handling, the chances of human error and accidents increases. Yet, there is a wide variation in the safety standards at the retail and distributor level. The regulations regarding propane dispensing facilities are most stringent in Ontario. The facility must have approved electrical installations, tanks, pumps, non-combustible building materials, and must be fenced.

6.2.2 Rail Transport

Rail tank cars are governed by the Canadian Transport Commission (CTC) and U.S. Interstate Commerce Commission rules and regulations, as well as those rules which are set by the American Society of Mechanical Engineers (ASME). Canadian standards for LPG tank cars are higher than U.S. standards. The propane industry, railways, and the Department of Transport monitor tank cars coming into Canada to ensure that they meet Canadian standards.

The railways have regulations governing permissible levels of tank car filling. All rail cars are roller bearing equipped and the newer cars are equipped with interlocking safety capped couplers to prevent tank car rupture from drawbars. In a mixed train, the propane tank cars are grouped and separated from other parts of the train by buffer cars. Rail tank cars which are dual purpose are purged before changing to alternate uses.

The regulations respecting transport of propane by rail have been thoroughly reviewed since the Mississauga derailment.

6.2.3 Truck Transport

The Boilers Branch or equivalent in many of the provinces inspects all registered tanks which are of a permanent nature, as well as all truck transport units. The provincial agencies utilize the ASME Code as well as the CSA Code B149.2 and their own provincial standards.

6.2.4 Pipeline Transport

At present there is no pipeline transport of propane in Ontario. Pipeline shipment of propane is likely in the future. Safety regulation of pipelines is the responsibility of the provincial government.

6.2.5 Retail Distribution

The Canadian Transport Commission inspects all thin-walled cylinders (i.e., holiday trailer tanks) using the United States Non-Governmental Compressed Gas Association Regulations as a manufacture standard. This role originates from the early transport of imported propane in cylinders by rail.

All other aspects of the retail distribution of propane are regulated by the Fuels Safety Branch of the Ontario Ministry of Consumer and Corporate Relations.

6.2.6 Insurance and Enforcement

Existing safety regulations do not mandate minimum levels of insurance coverage for the owners and/or operators of facilities where propane is stored or dispensed, as is required in the United States. Most prudent operators have insurance coverage. The possibility of establishing minimum levels of insurance coverage should be considered in light of the probable expansion of propane use for transportation purposes.

Regulations are only effective if they are followed. As the use of propane increases, it will be increasingly difficult (but increasingly important) to have careful monitoring to ensure that regulations are being followed. A mandatory insurance provision would assist in this regard since insurance company inspectors will supplement the government's enforcement activities.

6.3 SAFETY RISKS IN BULK TRANSPORTATION AND STORAGE

6.3.1 Pipeline Transport

Pipelines which carry propane encounter unique problems as compared to the transportation of other liquid fuels because the propane vapourizes when pressure is released. The hazards from a leak with propane are much greater than with gasolines, diesel oils, or other liquid fuels normally carried by product pipelines. Therefore, specialized pumping and terminal equipment must be installed and higher standards of pipeline maintenance need to be implemented.

There are over 350 000 km of LPG pipelines in the United States. The experience in that country indicates that pipelines are the safest mode of bulk propane shipment.

6.3.2 Rail Transport

The safety problems with rail transport of propane stem from the risk of railway accidents. The accidents are due to human error and mechanical failure. The principal concern related to propane safety in a railway accident is a derailment involving propane tank cars. In a derailment a tank car may be ruptured by the couplers of adjacent cars. Once a tank car containing propane is ruptured a fire and/or explosion is likely. Once a fire is started adjacent propane cars may explode due to the heat build-up or add fuel to the fire as propane is released by the pressure relief valves.

6.3.3 Truck Transport

Whenever propane is being transported by truck, there is always the danger of vehicle traffic accidents, as with any other vehicle. The potential damage from an accident is much greater when the propane cargo becomes endangered, partly because vehicle motors are a source of ignition for the propane.

A tank truck has roughly one-third of the capacity of a rail tank car. The likelihood of an accident involving two or more propane tank trucks is very remote, while rail accidents with propane tank cars often involve two or more cars. The severity of the fire and/or explosion in a truck accident is generally less than that of a rail accident. On the other hand, there is much more human involvement with propane transport by truck than by rail, so the incidence of truck accidents is higher.

6.3.4 Accident Risks for Rail and Truck Transport of Propane

A recent study for the U.S. Department of the Environment estimated the risks of shipping propane by truck and train. Trucks and rail tank cars are assumed to meet U.S. Department of Transportation specifications MC331 and 112J340W respectively. The accident rate for tank trucks is one per 645 000 km. Release of propane under normal conditions or in accidents occurs at a rate of once per 1.9 million km or one accident in three. Incidents that involve release of sufficient propane to cause a fire and/or explosion with loss of life occur at a rate of one per 14.7 million km. In other words, roughly one accident in 25 or one of eight significant propane spills involves loss of life.

The corresponding figures for rail tank cars are one accident per 160 000 km; release of propane under normal conditions or in an accident: one in 240 000 km; and loss of life accidents involving propane tank cars: one in 19.2 million. In terms of serious accidents, rail is safer than truck transport for bulk propane shipments.

Based on projected 1985 movements in the U.S. the total and individual risk of death due to rail and truck transport of propane are compared to those due to other accidents and natural disasters in Table 6.1. The risk of death due to bulk propane shipment is roughly half that associated with truck transport of gasoline.

Applying the American accident rates to the transport of propane consumed in Ontario indicates an average of 22 accidents per year (3 tank truck and 19 rail) and an average of 14 serious propane spills per year. Loss of life due to accidents involving bulk transportation of propane averages 0.3 persons per year, or one life every three years. These figures do not include accidents associated with propane shipments through the province.

As propane consumption in Ontario increases, the number of accidents can be expected to rise, but not in proportion. Increased consumption will make pipeline shipment of propane economic. Hence the volume of tank truck and rail shipments will not rise in proportion to consumption.

6.4 LOCAL DISTRIBUTION

6.4.1 Accident Risks for Bobtails

Local delivery trucks are commonly called bobtails. They have a capacity of about 10 000 litres, about one-quarter of the capacity of a tank truck.

The Pacific Northwest Laboratories study found the accident rates for bobtails to be roughly the same as for tank trucks; one accident per 645 000 km. The number of accidents was also found to be of the same order of magnitude as for tank trucks because the average distance of bobtail shipments is about 40 percent of that by tank truck, but there were more than twice as many shipments. Similarly the reduced risk of serious spills due to the smaller load is offset by the fact that more of the bobtail travel is through populated areas.

TABLE 6.1

AVERAGE TOTAL AND INDIVIDUAL RISK FROM VARIOUS ACCIDENTS AND NATURAL DISASTERS

Event	Total Risk (fatalities/year)	Individual Risk[a]
All Accidents	103 030[b]	1 in 2 000
Motor Vehicle Accidents	46 700[b]	1 in 5 000
Air Crashes	1 552[b]	1 in 140 000
Dam Failures	35[c]	1 in 6 300 000
Gasoline Delivery Trucks	28[d]	1 in 7 900 000
Propane Shipments	15	1 in 15 000 000
Air Crashes (persons on ground)	6[e]	1 in 33 000 000[f]
Meteorites	1.0×10^{-3}[g]	1 in 2×10^{11}

(a) Based on total U.S. population (220 000 000)

(b) Based on 1975 statistics

(c) Average for dam failures 1889-1972

(d) P.E. Rhoads, et.al., An Assessment of the Risk of Transporting Gasoline by Truck, Pacific Northwest Laboratory, Richland, Washington, November, 1978.

(e) Average for years 1960-1973

(f) Based on population at risk

(g) Reactor Safety Study - An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants, U.S. Nuclear Regulatory Commission, Washington D.C., October, 1975.

6.4.2 Risk of Spills During Loading and Unloading

Spills during loading or unloading of bobtails is a major concern. Such a spill could result in an explosion and fire involving the bobtail and storage tanks as well as the spilled propane. Most jurisdictions, including Ontario, require that loading be performed by a trained attendant other than the driver.

Whenever there is human handling of propane there is a risk of accidents. In loading and unloading bobtails the principal risk is that of spills due to improper connection of valves and hoses. Regulations designed to minimize the incidence and severity of spills are in place. The storage tank is required to be separated from the loading/unloading area by a concrete wall or bulkhead. The valves are protected by crash posts. Emergency shut off valves with several releases are required.

The risk of severe accidents can be further minimized by situating the tank and truck loading/unloading position at right angles to one another and having the ground slope away from both. Any spilled propane would move down the slope away from the truck and storage tank. A fire would follow the propane back to the source of the leak, then the flames would shoot outward in the direction of the flow of propane. So it is unlikely that both the truck and the storage tank would be exposed to the fire.

6.4.3 Refilling Cylinders

Cylinders can be safely refilled if the existing regulations are followed. The propane storage tanks must be isolated so the risk of fire or explosion and the damage in the event of an accident are minimized. Refilling should be done by trained personnel.

The most common problem is over-filling the cylinder. Whenever capacity limits are exceeded, either through the ignorance of the service personnel or through customer ignorance (customers often encourage filling tanks and cylinders to 100 percent capacity), hazardous situations result. When a propane tank or cylinder is filled to capacity, the lines to appliances and the appliances or other propane burning equipment usually become flooded with liquid propane which expands by a factor of 260 to 1 when pressure is released and it vapourizes. The resulting condition is extremely dangerous.

6.5 VEHICULAR USE OF PROPANE/BUTANE

6.5.1 Conversions

Ontario requires installers to take an examination on propane conversions as part of a motor mechanics course. Most American states use the National Fire Protection Association's Pamphlet No.58 as the basis for their regulations governing propane conversion.

The view of the government of the Netherlands, where there are about 220 000 LPG fuelled cars, is that these cars have a good safety record relative to gasoline powered vehicles. The accidents which have occurred were due to do-it-yourself conversions.

Training of mechanics in the installation and maintenance of propane conversions will be essential as the vehicular use of propane fuel grows.

6.5.2 Vehicle Refuelling

Ontario currently requires that refuelling be done by a qualified attendant. Some European countries and American states allow self-serve refuelling with proper facilities. As the use of propane for transportation fuel grows in Ontario it will be necessary to review the regulations governing vehicle refueling for possible introduction of self-service refuelling.

6.5.3 Accidents Involving Propane Vehicles

The TNO Research Institute for Road Vehicles in the Netherlands performed a series of safety tests on propane vehicles. These involved head-on and rear-end crashes at various speeds, crashing the tank directly against a wedge-shaped piece of steel and subjecting the tank to a fire. The research showed that:

- the automotive tank was able to withstand all crashes without leaking. In some cases when the appurtenances-- fuel line and external filling valve-- were hit, some leakage occurred from these areas.
- the wedge-shaped steel crashes caused major deformation (impressed 40 percent) of the tank but no leakage from the tank and only occasional leakage from the appurtenances.
- an automotive tank in direct flame showed a limited size of flame and very low pressure build up compared to burst pressure.

Overall the risk of fire and/or explosion in an accident involving a propane fuelled vehicle was found to be significantly lower than the risk of fire in gasoline powered vehicle accidents.

Additional copies are available from:
The Ontario Government Bookstore, 880 Bay St., Toronto for personal shopping. Out-of-town customers write to Publications Services Section, 5th Floor, 880 Bay St., Toronto M7A 1N8. Telephone (416) 965-6015. Toll free long distance 1-800-268-7540, in area code 807 dial 0-Zenith 67200. Mastercard and Visa accepted. Cheques and money orders payable to the Treasurer of Ontario.
Price: $2.00 per copy